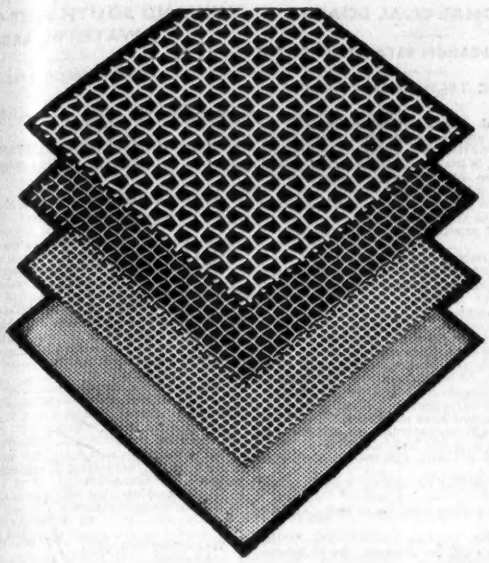

Very Versatile

IN many different metals, coarse mesh or fine, light gauge or heavy, 'Harco' Woven Wire is finding its way into more and more industries.

For Screening, Sorting or Sifting it is used in the grading of many types of material and products, from heavy minerals to fine powders.

For Filtering it plays a vital part in many kinds of mechanical equipment, and in the processing of liquids.

For Restricting Access—whilst allowing for the free passage of air—it is used for such diverse purposes as shielding commutators and excluding the common fly.

For Reinforcing Sheet Materials it gives greatly enhanced strength without sacrifice of flexibility.

For Improving Presentation its appearance and adaptability are important factors in industrial design.

'Harco' Woven Wire

Please ask for Catalogue No. E269.

Harvey

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Woolwich Road, London, S.E.7.
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THE ENGINEER

ESTABLISHED 1856

Vol. 198 No. 5142

AUGUST 13, 1954

28, Essex Street, Strand, London, W.C.2

Telephone : CENtral 6565 Telegrams : Engineer Newspaper, Estrand, London

Published every Friday Registered as a Newspaper

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NOTICE TO READERS
All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

THE UNIVERSITY OF LIVERPOOL

DEPARTMENT OF METALLURGY

LECTURER

Applications are invited for the post of LECTURER in the Department of Metallurgy, at an initial salary within the range £550–£1100 per annum, according to the qualifications and experience of the successful candidate. Applicants should be Honours Graduates with a knowledge of advanced physical metallurgy, and an interest in X-ray metallography.

Applications, stating age, qualifications and experience, together with the names of three referees, should be received not later than 1st September, 1954, by the undersigned, from whom further particulars may be obtained.

STANLEY DUMBELL,
Registrar.

E9861

THE UNIVERSITY OF LIVERPOOL

LEVERHULME POST-GRADUATE FELLOWSHIP IN ENGINEERING

Applications are invited for a LEVERHULME POST-GRADUATE FELLOWSHIP IN ENGINEERING, available for post-graduate work in any department of the Faculty of Engineering. The Fellowship, value £500, will be tenable for one year, but may be renewed for a second year at a value of £550.

Applications, stating age, whether National Service requirements have been fulfilled, experience and qualifications, and proposed field of research, together with the names of two referees, should be received not later than 1st September, 1954, by the undersigned, from whom further particulars may be obtained.

STANLEY DUMBELL,
Registrar.

E9969

UNIVERSITY OF SYDNEY, AUSTRALIA

LECTURER IN ELECTRICAL ENGINEERING

Applications are invited for the position of LECTURER IN ELECTRICAL ENGINEERING. Applicants should have had experience in the field of interconnected power systems.

The salary for a Lecturer is within the range of £A1100–£A1450 per annum, with annual increments of £A50. The salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Finance available for home purchase under staff members' housing scheme.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5, Gordon Square, London, W.C.1.

The closing date for the receipt of applications, in Australia and London, is 28th August, 1954. E9973

THE UNIVERSITY OF LEEDS

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for appointment as LECTURER in MECHANICAL ENGINEERING at a salary on the scale £550 by £50 to £1100, according to qualifications and experience. Candidates should have an Honours Degree and some practical experience.—Applications (three copies), stating date of birth, qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained), not later than 13th September, 1954. E5000

THE UNIVERSITY OF SHEFFIELD

LECTURER IN MECHANICAL ENGINEERING

Very considerable extensions in accommodation requirements to the Engineering Departments having been completed, applications are invited for Two posts of LECTURER in MECHANICAL ENGINEERING, to begin duties on 1st October, 1954, or as soon as possible thereafter. Salary scale, £550 by £50 to £1100, with F.S.S.U. provision and family allowance. Initial salary on the scale according to qualifications and experience.—Further particulars should be obtained from the Registrar, to whom applications (4 copies) should be sent by 30th August, 1954. E9809

WEST RIDING COUNTY COUNCIL

CASTLEFORD, WHITWOOD MINING AND TECHNICAL COLLEGE

ASSISTANT GRADE B

Required for September, 1954, or as soon thereafter as possible: Engineering Department—ASSISTANT Grade B, to teach Heat Engines and other subjects to Higher National Certificate standard. Applicants should possess suitable qualifications and have had industrial experience and teaching experience in National Certificate Courses.

Salary: £525 by £25–£820, with additions for Graduate qualifications and approved training.

Application forms, obtainable from the undermentioned, should be returned within 14 days of the appearance of this advertisement to:—

M. G. Swaine, 2, Wesley Street, Castleford.

E9988

PUBLIC APPOINTMENTS

THE UNIVERSITY OF MANCHESTER

SENIOR LECTURESHIP AND TWO LECTURESHIPS IN ENGINEERING

Applications are invited for a SENIOR LECTURESHIP and TWO LECTURESHIPS IN ENGINEERING. Candidates for the Senior Lectureship and one of the Lectureships should have special qualifications in mechanical engineering, with particular interest in one or more of the following:—Heat Transfer, fluid mechanics, thermodynamics applied to heat engines, theory of machines. Candidates for the other Lectureship should have special qualifications in civil engineering and should preferably have interests in surveying or hydraulics, but this is not essential. Salary scales: Senior Lectureship, £1150–£1500 per annum; Lectureship, £500–£1100 per annum. Membership of F.S.S.U. and children's allowance scheme. Initial salary according to qualifications and experience.—Applications should be sent not later than 4th September, 1954, to the Registrar, The University, Manchester, 13, from whom further particulars and forms of application may be obtained. E9887

SUDAN GOVERNMENT

BUILDING DEPARTMENT

LECTURER

The Director of Education invites applications from suitably qualified candidates for the posts of LECTURER in the Building Department of the Khartoum Technical Institute. Candidates should possess a degree or other relevant technical qualification, such as A.M.I.C.E. or A.R.I.B.A., and should not be less than 30 years of age on appointment. Industrial experience is essential and experience in a similar appointment would be an advantage. One of the posts is available for Structural Engineers only.

Successful candidates will be required to teach their subjects to Higher National Certificate standard, and will also be required to supervise certain workshop and laboratory activities.

Appointment will be on short term contract with bonus determinable at any time by six month's notice from either side, provided that on or after the 1st April, 1955, the period of notice shall be three months and not six. Salary scale ranges from £E.1075 to £E.1675 p.a. Point of entry into this scale will be determined according to age, qualifications and experience. A cost of living allowance, which is reviewed quarterly, is also payable. Outfit allowance of £E.50 on appointment and free passage. There is at present no income tax in the Sudan.

Further particulars and application form will be sent on receipt of a postcard only addressed to The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "S. Asst. Building 1010," and name and address in block letters. E5042

BRITISH ELECTRICITY AUTHORITY

MIDLANDS DIVISION

ASSISTANT ENGINEERS

Applications are invited for the following positions in the Civil Engineering Section of the Construction Department. N.J.B. service conditions, superannuable appointments, salaries within Schedule "C" of the agreement:—

(a) THIRD ASSISTANT ENGINEER (Civil) at Ocker Hill power station site, Grade 5, £649 to £790, ultimately rising to £858 per annum. (Vacancy No. 735MD.)

(b) GENERAL ASSISTANT ENGINEER (Civil) at Hams Hall "C" power station site, Grade 6, £584 to £720, ultimately rising to £787 per annum. (Vacancy No. 736MD.)

Applicants for (a) should have a thorough experience in the design, setting out and supervision of site works, foundations, buildings, and in particular reinforced concrete structures. They must have had considerable experience in the use of the level and theodolite, and should also be accustomed to specifications, bills of quantities, drawings, correspondence and site procedure.

The successful applicant for (b) will be expected to act as assistant to the Authority's site engineer and should have had similar experience to (a).

For both positions appropriate technical qualifications will be an advantage.

Apply, quoting the vacancy number, on form AE6, available from the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 28th August, 1954. E5019

MID AND SOUTH EAST CHESHIRE WATER BOARD

APPOINTMENT OF CHEMIST

Applications are invited for the above permanent appointment, Grade A.P.T. X (£920–£1050), subject to National Conditions of Service, Local Government Superannuation Acts; medical examination and termination by one month's written notice on either side.

Experience in the treatment and examination of water supplies is essential and candidates should be Members of the Royal Institute of Chemistry and/or possess an Honours Degree in Chemistry.

Applications, containing particulars of age, qualifications and experience, are to be addressed to Mr. Delwyn G. Davies, Engineer and Manager, by the 7th September, 1954, together with the names and addresses of three referees. Canvassing will disqualify. Applicants must state whether to their knowledge they are related to any member or senior officer of the Board.

C. J. WALKER,
Clerk and Accountant.

Weaverham Grange,
Hartford,
Near Northwich,
Cheshire,
23rd July, 1954.

E9885

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

CENTRAL RESEARCH ESTABLISHMENT II

SCIENTIFIC TECHNICAL OFFICERS

National Coal Board invite applications for superannuable appointments as SCIENTIFIC TECHNICAL OFFICERS at their Central Research Establishment II, in Isleworth, Middlesex. The work undertaken is on basic principles and staff are required for the following fields:—

(1) Problems in the control and improvement of working conditions in mines.

(2) Mechanical properties of coal of relevance to coal winning.

(3) Technical methods of coal winning.

(4) Design of experimental coal-getting machinery.

(5) Technical problems arising in coal transport, roof support, &c.

(6) Metallurgy, and

(7) Instrumentation for use in mines and laboratory in connection with the above problems.

It is desirable that candidates should have at least General Certificate of Education at Advanced Level in Science subjects or Higher National Certificate in Mechanical or Electrical Engineering or Applied Physics. Previous experience in laboratory work or instrumentation would be an advantage.

Appointments will be, according to qualifications and experience, as Scientific Technical Officers.

Grade I (scale £730 by £25–£880). Reference No. TT/816.

Grade II (scale £485 by £20–£705). Reference No. TT/817.

Grade III (scale £375 by £20–£535). Reference No. TT/818.

London Location Allowance of £32 10s. at the minimum, rising to £62 per annum at the maximum of the above scales is payable in addition.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting this paper and marking envelope with the relevant TT Reference Number quoted above. Original testimonials should not be forwarded. Closing date 20th September, 1954.

E9962

GOVERNMENT OF QATAR

RESIDENT ENGINEER, WATER SUPPLY

Applications are invited from Corporate Members of the Institution of Civil Engineers for the above appointment.

The duties consist of the supervision of construction of a sea-water distillation plant; the erection of overhead and ground level storage tanks; the laying of distribution pipework; supervision of well drilling for underground water to augment the distilled water; the erection of pumping equipment, &c., in and around Doha.

The appointment is expected to last 18 months.

Applicants should be between the ages of 30 and 40.

The salary offered is in the range 2000 to 2400 rupees per Arabic month. There is at present no income tax in Qatar.

Bachelor quarters only will be provided, but a wife may be allowed to join her husband during the summer leave season.

Air passages on joining and termination, medical attention, light and water are provided free.

Applications to J. D. and D. M. Watson, MM.I.C.E., 18, Queen Anne's Gate, Westminster, London, S.W.1. E5016

MINISTRY OF WORKS

RISLEY

STRUCTURAL ENGINEERING DRAUGHTSMEN

STRUCTURAL ENGINEERING DRAUGHTSMEN required in London, Risley (near Warrington) Harwell (near Didcot), Reading, Cambridge, Leeds, Manchester, Cardiff and Edinburgh.

Accommodation for single men at Risley and Harwell.

London salary: up to £670 per annum. Starting pay up to £580 per annum, according to age, qualifications and experience. Elsewhere slightly less.

Experience required in design and/or detailing of reinforced concrete or structural steelwork. Work varied and not confined to standard schemes.

Reasonable prospects of promotion. Although not established posts, many have long-term possibilities. Competitions held periodically for established vacancies.

Write, stating age, nationality, experience and locality preferred, to W.G.10/S.5 (H), Ministry of Works, Abell House, John Islip Street, London, S.W.1. E8934

CIVIL SERVICE COMMISSION

CIVIL ENGINEERS IN GOVERNMENT DEPARTMENTS

The Civil Service Commissioners invite applications for pensionable POSTS. Provisionally the latest date for applications is 31st December, 1954, but an earlier date may be announced and early application is advised.

Age at least 25 and under 35 on 1st January, 1954 with extension for regular service in H.M. Forces and up to two years for permanent civil service. Candidates must be Corporate Members of the Institution of Civil Engineers or have passed or been exempted from Sections A and B. Wide professional experience expected.

London salary scale (men) £650 (at age 25) to £1000. Starting salary according to age up to £900 at 34. Prospects of promotion. Salaries of next higher grades are £1000–£1320 and £1375–£1575. Somewhat lower for women and in the provinces.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S64/54

E9995

PUBLIC APPOINTMENTS

MID AND SOUTH-EAST CHES WATER BOARD

APPOINTMENTS

(1) ASSISTANT ENGINEER, A.P.T. GRA (£735–£810)

(2) ENGINEERING ASSISTANT, A GRADE V (£620–£670)

Applications are invited for the above po appointments, which are subject to the Conditions of Service, Local Government annuation Acts; a medical examination and tion by one month's written notice on either

Candidates for the post of Assistant Engine be chartered civil engineers, preferably with Engineering Degree, and have had experi the operation, design and construction of wat

For the post of Engineering Assistant ca must have experience in waterworks des construction, and possess a Civil Engineering or Parts I and II of the examinations of the In of Civil Engineers.

Applications, containing particulars of ag fications and experience, are to be addressed Delwyn G. Davies, Engineer and Manager, 7th September, 1954, together with the n addresses of three referees. Canvassing qualify, and applicants must state whether knowledge they are related to any member o officer of the Board.

Careful consideration will be given to the p of housing accommodation if required.

C. J. WALKER,
Clerk and Accou

Weaverham Grange,
Hartford,
Near Northwich,
Cheshire,
23rd July, 1954.

CIVIL SERVICE COMMISSIO

PROFESSIONAL ENGINEERS IN VA GOVERNMENT DEPARTMENT

The Civil Service Commissioners invite app for pensionable POSTS in a wide variety of me and electrical engineering duties. Provisio latest date for applications is 31st Decembe but an earlier date may be announced and ear cation is advised.

Candidates must be under 35 on 1st Januar with extension for regular service in H.M. For up to two years for permanent civil service. Post Office they must be at least 21, for the M of Supply and Ministry of Transport and Civ tion at least 23, and for all other Departments 25 on that date.

Generally a candidate must possess a U Degree in Engineering or be a Corporate Me one of the professional institutions—Me Engineers, Electrical Engineers, or Civil Engi have passes in, or exemption from, Sections of the corresponding Associate Membership e tions. Exceptionally candidates of high prof attainment, but without the specified qualifi may be admitted. For some posts Associate ship of the Royal Aeronautical Society or an H Degree in Physics or Engineering will be acc

London salary scale (men) £650 (at age £1000. Starting salary according to age up at 34. Candidates entering below age 25 wil salaries varying from £450 at age 21 to £570 a Prospects of promotion. Salaries of next grades are £1000–£1320 and £1375–£1575. Sc lower for women and in the provinces.

Further particulars and application for Civil Service Commission, Scientific Branch, Burlington Street, London, W.1, quoting No.

BRIDGE DESIGNER

LONDON OFFICE

BRIDGE DESIGNER required for their office by the Crown Agents for Oversea Gov and Administrations. Appointment will b Engineer Grade on the salary scale £1000 t £1320 a year plus extra duty allowance of mately 8 per cent. Engagement on unes terms with prospect of appointment to the e staff after five years' service and of pr Candidates should be not less than 34 years They should be good draughtsmen and sho had considerable experience in making putations and in preparing detailed design types of steel bridges. A knowledge of re concrete and experience in a bridge build will be an advantage. Corporate Members Institution of Civil Engineers or of the Insti Structural Engineers is essential—Write to the Agents, 4, Millbank, London, S.W.1. St name in block letters, full qualifications and ence, and quote M2A/30577/EH.

COUNTY BOROUGH OF EAST

APPOINTMENTS

JUNIOR ENGINEERING ASSISTANT, £490–£535.

TEMPORARY ESTIMATOR, Grade £670.

SENIOR QUANTITY SURVEYOR, G £695–£760.

SENIOR ENGINEERING ASSISTAN VI, £695–£760.

London weighting is paid in addition. excess of the minima may be paid according cations and experience.

Subsistence allowances may be grante reasonable period to persons appointed if obtain suitable housing accommodation, not the maintenance of two homes.

Further details and application forms, by 27th August, 1954, from the Town Cle Hall, East Ham, E.6.

THE ENGINEER

AUGUST 13, 1954

Aircraft Manufacturers' Agreement for "Britannia" Production

IT has been announced by the board of Short Brothers and Harland, Ltd., Belfast, that it has increased its issued share capital by £360,000 to £2,360,000, and that this increment has been acquired by the Bristol Aeroplane Company, Ltd. Sir Reginald Verdon Smith and Mr. Cyril F. Unwin, of the Bristol Aeroplane Company, Ltd., have been elected to the board. An earlier production agreement between these companies was signed last December, according to which Short Brothers and Harland, Ltd., was to prepare capacity at its Belfast works for production of the Bristol "Britannia" airliner. The agreement had been prompted by the inability of the Bristol company to meet the anticipated demand for this aircraft from its own production capacity of twenty-five aircraft a year. Jigging and tooling for an identical production rate is now on hand at Belfast.

More "Viscounts" Ordered for the United States

IT is announced by Vickers-Armstrongs, Ltd., that Capital Airlines, one of the largest domestic airlines in the United States, has exercised its option to purchase a further thirty-seven "Viscount" airliners. This brings the total number of "Viscounts" ordered by Capital Airlines to forty, the first three aircraft having been ordered in June, 1954. The same company has taken an option on a further twenty "Viscounts" with the intention of standardising its entire fleet with a total of sixty aircraft of this type. This is stated to be the biggest single sale yet made of a British airliner, and so far as can be ascertained it is the largest single commercial dollar export order placed with a British company in any industry since the end of the war. The confirmed order for the forty "Viscounts," with spares, is valued at £15,750,000, and the further twenty aircraft, if purchased, would represent an additional £8,000,000. Deliveries of the aircraft will start in March, 1955, and will be completed in August, 1956. If the further twenty "Viscounts" are ordered they will be delivered between September, 1956, and February 1957.

Inquiry into the Electrical Supply Industry

THE committee of inquiry into the electricity supply industry in England and Wales, which was appointed early in July under the chairmanship of Sir Edwin Herbert, has invited a number of organisations, representative of various consumer interests, to submit evidence on any matter within the scope of the inquiry which they may wish to bring to the attention of the committee. Among the organisations approached are those representing local authorities, the Federation of British Industries, the National Union of Manufacturers, the Association of British Chambers of Commerce, the Co-operative Union, the National Chamber of Trade, the Retail Distributors' Association, the Trades Union Congress, the National Farmers' Union, the Country Landowners' Association, and a number of women's organisations. The committee is prepared to accept representations from any consumer or group of consumers, and we are informed that in all cases evidence, accompanied by any recommendation for improved service, should be submitted before the end of September. The representative consumer organisations have been asked, in particular, to give their observations upon the structure of electricity tariffs and methods of charging for electricity; the quality of electricity supply and service, including the supply of various types of equipment, with reference particularly to any changes for better or worse consumers may have observed since 1947; and the effectiveness of electricity consultative councils to represent and safeguard consumer interests. Consultative councils have also been asked to submit their views.

British Association's Meeting at Oxford

THE programme has now been published for the 116th annual meeting of the British Association for the Advancement of Science, which is to be held at Oxford from September 1st to 8th. It is the sixth such meeting to be held at Oxford, the last occasion being in 1926. This year, the president of the British Association is Dr. E. D. Adrian, O.M., F.R.S., and his address, entitled "Science and Human Nature," will be delivered on Wednesday evening, September 1st, in the Sheldonian Theatre. This inaugural session will be preceded by a Convocation of the University of Oxford, when the vice-chancellor will confer the honorary degree of doctor of science on Sir Ben Lockspeiser, F.R.S., Sir John Lennard-Jones, F.R.S., and Sir Harold Spencer Jones, F.R.S. The meetings of section G (Engineering) are to be held for the most part in the inorganic chemistry and old geology lecture theatres of Oxford University. Dr. Willis Jackson, F.R.S., is the president of the section. The sectional meetings will begin on Thursday morning, September 2nd, and Dr. Willis Jackson will deliver his presidential address, entitled "The Effect of New Materials on Engineering Progress," on Friday morning, September 3rd, in the University Museum Theatre. In other sections, there are many matters of interest to engineers, especially in section A, which deals with mathematics and physics. Sir John Cockcroft, F.R.S., is the president of this section, and will deliver an address on "Recent Developments in Nuclear Physics," on Thursday morning, September 2nd. In all the sections of the Association, an extensive programme of visits has been arranged, and special exhibitions are being prepared at the museums and libraries in Oxford. They include an exhibition at the Ashmolean Museum, illustrating the history of metrology, and a display of the J. A. Billmeir collection of scientific instruments (13th to 19th centuries) at the Museum of the History of Science. Throughout the meeting, the Association's reception room and offices will be at Rhodes House, South Parks Road, Oxford.

Suez Canal Base

DURING recent weeks the Government has consulted with the Federation of British Industries about the practical and organisational problems which would be involved if the Suez Canal base were to be maintained by British civilian firms. Now that heads of agreement have been initialled arrangements have been made to form a civilian survey mission which is to go out to the canal base this week. The mission will study the problems connected with the future maintenance of the Suez Canal base by civilian contractors. It is led by Sir John Duncanson. Members representing civil engineering companies are :—Mr. R. Berridge (project manager, Richard Costain, Ltd.), Mr. D. Bilham (quantity surveyor, John Laing and Son, Ltd.), Mr. K. C. Gresham (electrical engineer, Balfour, Beatty and Co., Ltd.), Mr. J. C. R. Head (civil engineer, John Mowlem and Co., Ltd.), and Mr. A. C. Thomas (director, Taylor Woodrow Construction, Ltd.). The following are representatives of motor companies :—Major-General E. H. Clayton (general manager, service department, Austin Motor Company, Ltd.), Mr. S. Hollands (technical officer, A.C.V. Group), Mr. E. Holt (chief accountant, Dunlop Rubber Company, Ltd.), and Mr. S. J. Hine (managing director, Rootes Ltd.). The remaining members are :—Mr. E. H. Bruce-Clayton (air radio and planning superintendent, International Aeradio, Ltd), Sir Victor Tait (chairman, International Aeradio, Ltd.), Mr. J. H. Martin (special director and works manager, Vickers-Armstrongs, Ltd.), and Mr. W. R. Robson (director, metals division, Imperial Chemical Industries, Ltd.). Peat, Marwick, Mitchell and Co. have been appointed secretaries to the mission. The mission is expected to be away for about two weeks. Decisions about organisation and contracts will be deferred until its return. It will be accompanied by three representatives from the War Office as follows :—General Sir Ouvry Roberts (quartermaster-general), Major-General G. C. Humphreys, and Mr. F. M. W. Smith (assistant director of Army contracts).

Proposed Colliery in Scotland

IT has been announced by the Scottish division of the National Coal Board that work is shortly to begin on the construction and development of a new colliery near Burnton, Dalmellington, in Ayrshire. The new Minnivey Colliery, as it will be known, will cost some £540,000 to develop and will work reserves of coal estimated to total about 7,000,000 tons. It will take about four years to attain the full output of 750 tons a day, when it will provide employment for some 400 men. It is understood that eight seams varying from 2ft to 4ft thick, will be worked in the new mine, and it is expected that the coal will be of the same high quality as that obtained from other mines in the area.

Persian Oil Agreement

THE Anglo-Iranian Oil Company Ltd., stated on August 5th that agreement had been reached in Tehran with the Iranian Government on the question of compensation. Commencing on January 1, 1957, the Iranian Government would pay to the company a sum of £25,000,000 in ten equal annual instalments. Agreement regarding the world marketing of Iranian oil had also been reached in principle between the Iranian Government and a consortium of eight oil companies. The consortium would have the use in South Iran of the installation originally provided by Anglo-Iranian, who would have a 40 per cent interest in the consortium and would receive payment from the other members for the remaining 60 per cent. The compensation agreement formed an integral part of the general settlement. Having regard to the payments to be made to it by other consortium members, the company had not claimed compensation for loss of future profits, but had, in view of its continuing interest in the oil operations in South Iran, accepted the Iranian Government's offer in full and final settlement of all claims and counter-claims, so that a solution of the dispute might be reached. A full statement would be issued to stockholders after formal agreements had been ratified by the Iranian Majlis.

Some Notes on the Development of Fairground Machinery

By P. W. BRADLEY

No. V—(*Continued from page 185, August 6th*)

In this review of portable riding machines, there are included developments of the simple swing, the "Big Wheel," roundabouts with tilting axles or depending largely on the effect of centrifugal force, devices based on the action of the common crank, and passenger-steered "driving" machines.

BEFORE pursuing further the development of the circular track machine, it may be well to consider some of the other kinds of riding devices which have appeared at English fairs. The present article covers six classes of apparatus, namely, swinging devices, "Big Wheels," roundabouts with tilting axes, reciprocating novelties based on the action of the common crank, devices depending largely on the effect of centrifugal force, and, lastly, machines which are passenger-controlled in the matter of steering.

Little need be said about ordinary swings, utilising "boats" of a peculiar traditional outline which has scarcely changed in seventy or eighty years. In a wide range of sizes from 9ft to about 18ft high, and with from three to nine boats, this simple device has never lost its popularity. The first to attempt to mechanise swingboats seem to have been Wm. Reynolds (of "double-crank gallopers" fame) and P. Everitt, who, in 1886, jointly patented the machine nowadays known as the "Yorkshire Steam Swings," for it has been peculiar to that county for many years. Only one set is known to survive at the time of writing. In a frame resembling that of a traditional "adult" set of seven boats, but rather more substantially constructed, Reynolds and Everitt fitted six boats, and, centrally, a portable steam engine driving by belt a long "top shaft" which replaced the normal horizontal beam, being journalled in bearings at the apexes of the "A" frames. The boats were free to swing independently of this shaft, although suspended from it. Above each, a friction wheel was keyed to the shaft, which ran continuously in one direction, and a pressure pad could be brought into contact with the rim of the wheel by pulling on a rope which hung down to within the riders' reach. Anyone with a smattering of dynamics (and reasonably strong in the arms) could have a most exhilarating ride on this device; inversion was theoretically possible, and, according to Yorkshire showmen, has on rare occasions been achieved. The peculiar experience of swinging at considerably less than the natural rate was, if desired, another possibility.

The application of mechanical power to high-capacity swings attracted several inventors, but, as far as is known, the first to produce a practical design were Wm. Cartwright and Henry Cracknell, who, in a specification of 1888, described their "New or Improved Machinery for Working Swing Boats by Steam." Alongside one of the main "A" frames of the structure they placed a portable steam engine having a conventional locomotive-type boiler, but having a vertical cylinder with substantial crosshead guides above it. The crosshead was linked by a connecting-rod to a crank on the boat shaft at the summit of the "A" frames. The machine was arranged for a swing of nearly a semi-circle, and, until this amplitude had been attained, the slide valve was controlled by a hand lever. At full swing, a tappet on the crosshead operated the valve automatically, and at the end of the ride the hand control was again used, this time to admit steam against the natural swing of the boat and thus bring it to rest. In practice two boats were provided, the engine standing between them and having two cylinders with independent valve gear, only the boiler being common.

In 1894, before very many of these machines had been built, Wm. Cartwright, this time alone, patented an improved layout of the working parts, and so finalised the "Twin Steam Yachts" machine illustrated in Fig. 16. The improvement lay in the elimination of the direct unadjustable connection between crosshead and top crank, which had necessitated very accurate location of the portable engine. Cartwright arranged the cylinders horizontally, and fitted crankshafts and short connecting-rods in the normal portable engine manner. The engine was located so that the crankshafts lay below the inner ends of the top shafts. Lengths of chain were passed round chain wheels keyed to the crankshafts and boat shafts and connected together by two links, so as to form virtually a continuous chain. Each link was adjustable in length (through a screw and nut arrangement), and a vertical strut between crankshaft and boatshaft bearings was similarly adjustable.

Each time the machine was erected chain tension could be adjusted to a nicety, and, equally important, the motion could readily be set so that the pistons were precisely at mid-stroke when the boats hung horizontally. The valve gear (Fig. 17), automatic in operation at full swing and otherwise under hand control, was similar in principle to that of the original vertical-cylindered design. It is colloquially known as "rabbit" gear, since a tappet lever *A* resembling the outline of that animal (running and with mouth open), was pivoted at its mid-point to the upper slide bar *B*. A projection *C* from the crosshead engaged in turn the fore and hind "legs," whilst the "mouth" accommodated a pin *D* on one arm of a bell crank *E* linked to the slide valve, and, of course, to the hand lever through the rod *F*.

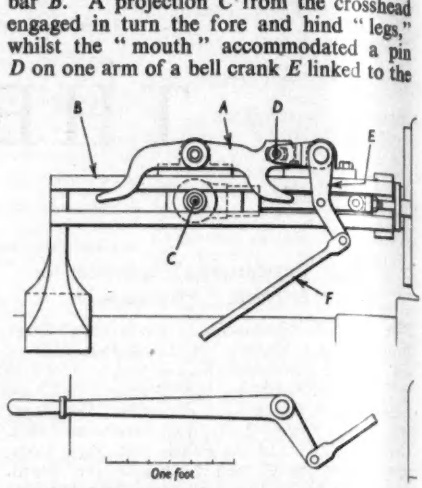

Fig. 17—"Rabbit" valve gear for steam "Yacht" patented by William Cartwright in 1894. The gear operated automatically only at full swing; hand control was used when starting and to admit steam against the natural swing of the boat at the end of the ride

The most efficient utilisation of the machine at busy periods requires an engine driver (for some mysterious reason known as a "pumper") able to start one boat whilst simultaneously bringing the other to rest, and this is a definite "knack," which comes only with experience. Experiments have been made from time to time with electric drive, using hand reversed motors, but most of the surviving sets (including a unique single boat in Lancashire) are still steam driven.

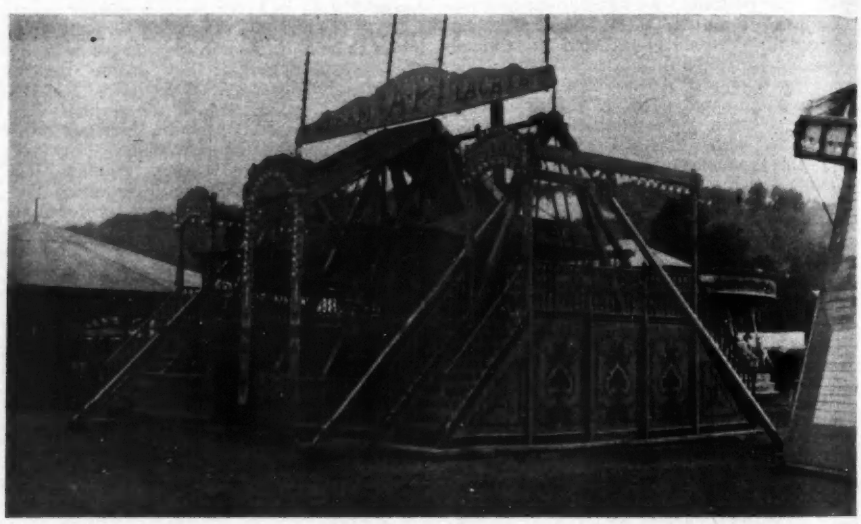

Fig. 16—"Twin Steam Yachts" machine, in which each boat seats about thirty-two riders and swings through nearly a semicircle at a rate of about thirteen complete cycles per minute

Transport of "Twin Steam Yachts" is a fairly simple matter. Two large flat trucks each carry a boat on suitable crossbearers at a height of about 18in above the platform. A part-length well in each accommodates one top-shaft unit, and the "A" frame components, sleepers, landings, &c., pack on the platforms, beneath and around the boats. These two loads, and the portable engine on its own wheels, are comfortably within the capacity of a 7 n.h.p. road locomotive, or the diesel equivalent. The only erection diffi-

culty lies in the hoisting of the top shafts (each complete with bearings and leg sockets, chain wheel and pair of boat brackets) to the top of the " A " frames. This is accomplished by rope and pulley tackle suspended from a set of tall sheer legs. The road wagons are run between the " A " frames so that the boats require only a slight lift before being attached to their suspension rods ; the trucks can then be withdrawn.

Since the " Steam Yachts " the only purely swinging fairground ride of any note has been the " Loop-o-plane," introduced in 1936 or thereabouts. The horizontal axis, in this case quite short, is supported not by " A " frames at its ends, but centrally on a single hollow steel column suitably stayed. Each of the two two-seater boats is carried on a rigid steel arm secured to a bearing running on the axis, and there is no provision for balancing. The swinging arms are driven through gear and chain reduction gearing from a reversible electric motor mounted on the central column near its upper end. There is no difficulty in describing complete circles with this device, but whilst swinging, the reversing controller requires skilful handling, otherwise motor and chain drives are heavily stressed. " Loop-o-planes " were never numerous, but a set appeared in Battersea Park for part of the second (1952) season.

From swinging rides we may logically turn to those of the " Big Wheel " family. This is basically a wheel turning on a horizontal axis, and carrying at intervals on its periphery carriages or the like suspended pivotally, so that they remain upright by their own weight. This device is of very early origin ; in his paper " The Evolution of Amusement Machines," Mr. Thomas Murphy established that it was known in Asia in 1620.

" Big Wheels " proper, having eight or twelve cars and steam propulsion, were occasionally seen at English fairs upwards of thirty years ago, but in those days the machine enjoyed more popularity as a permanent or semi-permanent construction on a far larger scale. There was, however, one interesting fairground variant on the normal design, in which the eight suspended cars were made circular and caused to revolve about vertical axes as the wheel turned. This was accomplished by keying a bevel gear to each suspension shaft (which, was fast to the wheel frame) and these drove similar gears on the vertical car axes.

After many years' absence the " Big Wheel " returned to our fairgrounds in 1945 or thereabouts ; now built largely of light steel sections, and with either petrol or electric drive.

In the smaller (twelve-car) size it achieved immediate popularity and sixteen-car examples are sometimes seen. Each car seats two adults or three children, and the total height from the ground is, in the case of the smaller machine, about 50ft. The means adopted for making the framework readily portable is ingenious and merits description, especially since the need for sheer legs (as used for " Steam Yachts " top shafts) has been eliminated. Fig. 18 shows in diagrammatic form one of the two supporting frames. The main uprights, square in section and of lattice construction, are formed in two portions *A* and *B*, coupled by overlapping plate joints in which are inserted long bolts D_1 and D_2. The main bearings for the wheel shaft are fitted at the upper end of *B*, and small rollers *G* are provided near their lower ends. The base members *C*, also of lattice construction, have inclined ends, and the uprights are braced to them by angle girders E_1 and E_2 and wire ropes *F* with strainers incorporated. In erecting the structure the uprights *A* are attached to *C* and the girders E_1 and E_2 added. Further bracing members support the structure laterally. In the meantime the uprights *B* and top shaft (complete with wheel hubs) are assembled on wooden planks *H* laid on the ground, and the driving unit (which for erection purposes also incorporates a capstan) is scotched in position at *J*. A wire rope and bridle is attached to the top shaft, and by means of the capstan the upper assembly is drawn forward ; the rollers *G* and wheel hubs running in turn on the planks *H*, the inclined ends of *C* and the girders E_1, until the bolts D_1 can be inserted. A temporary triangular wooden toggle *K* is then fitted and its upper end secured to the bridle. A further haul by the capstan, to the apex of the toggle, sets *B* into the vertical position ; bolts D_2 can then be inserted and the ties *F* added. After assembly of the wheel and cars the power unit is brought closer to the machine, where it drives through a flat belt and spur reduction gearing a double pulley around which the main propulsion rope passes. Deep-grooved carriers for this rope are fitted near the outer end of each " spoke." The large belt pulley incorporates a combined friction clutch and brake arrangement under the control of the operator.

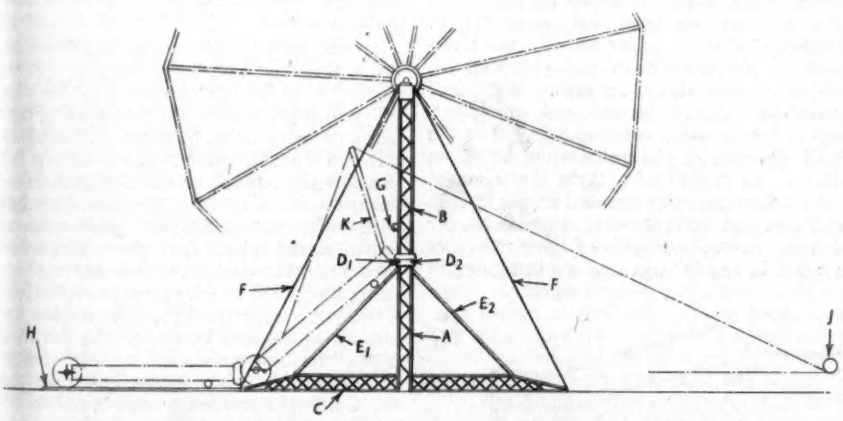

Fig. 18—Diagram of the modern " Big Wheel," showing the sequence of operations. The same power unit is used to erect the fixed structure and to drive the " Wheel "

The only subsequent development of the " Big Wheel " principle has been the " Sky Wheels " machine, introduced at Battersea Park in 1951. This device is necessarily very large and heavy and, as an amusement park feature, it hardly falls within the scope of these notes ; but it deserves mention as it amounts to a combination of two early fairground rides, the overboats and " Big Wheel." The extremities of a centrally pivoted revolving arm form the bearings for two wheels, each carrying eight two-seater cars and about 25ft in diameter. The arm length is about 45ft, and its axis is at about that distance from the ground. An electric motor at ground level rotates the arm by means of a rope drive, and the wheels are turned (in the same direction as the arm) through friction drives from two further motors carried on the arm ; these are fed through separate sliprings, and are therefore separately controllable.

One interesting development of the ordinary roundabout lay in the application of a tilting motion to the normally vertical

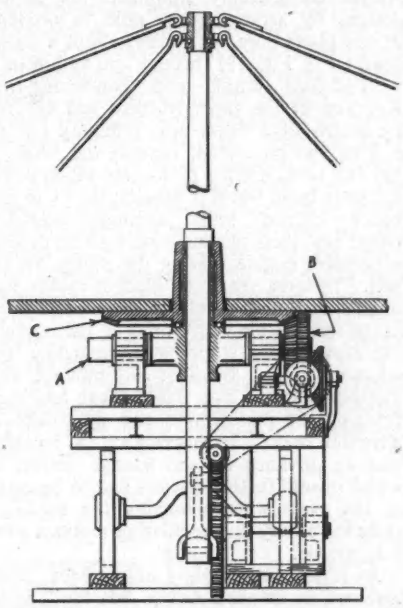

Fig. 19—The " Razzle-Dazzle " in its final (1904) form, with a tilting axis rocking about a crosshead just below platform level. The platform was rotated through bevel gearing and the vertical axis rocked by a simple crank motion

axis. A partly completed sketch preserved in Savages' drawing-office establishes that this possibility was seriously considered as early as 1891. The idea apparently was to mount a roundabout " pole " in a universal joint on trunnions. A downward prolongation of the pole, below this support, ended as a ball which fitted in a cup secured to the face of a large spur wheel running on a vertical axis concident with that of the pole when in the vertical position (which, in the arrangement as sketched, it would never attain). The intended layout of trunnions, spur gear, &c., in a " centre-truck " is clearly shown, as is the position of the portable steam engine and reduction gearing ; but not, unfortunately, the means whereby the roundabout was to be caused to revolve about the " pole."

Savages advanced the scheme to the practical stage, and an illustration of it appears in the booklet published in celebration of their centenary in 1950. Unfortunately, records no longer exist of the design of the mechanism, but there is little doubt that it was a development of the idea sketched in 1891. Two facts have been established : first, that the pole was mounted on some kind of universal joint, and rocked in several planes, and, secondly, that the machine was from the outset designed for electric drive. Apparently, very few were built. Search at the Patent Office has not revealed any further information, save that in 1893 F. W. Savage patented an arrangement wherein a normal roundabout pole was universally jointed at cheesewheel level, so that the revolving portion was free to swing as it rotated. This,

however, is not the machine concerned (although a near relation), and no evidence has been traced of its actual construction.

Tilting axis roundabout design was effectively finalised in 1904, when Edward Amyes, mechanic, of Salford, patented the machine which later became known as the "Razzle-Dazzle." One of the drawings which accompanied his specification is reproduced in Fig. 19, and the practical design closely followed this arrangement. These machines were built by Messrs. Howcroft, of West Hartlepool, and became quite popular; one working example survived at least until 1950, and possibly later. It will be seen that Amyes considerably simplified the earlier designs by arranging the pole to oscillate in one plane only. It rocked about a crosshead (*A* in Fig. 19) through the action of a worm-driven crank and connecting-rod. Rotation of the superstructure was effected by means of a bevel gear (running on the end of the crosshead, outside the bearing, but fast to its driving pinion *B*), which drove the large bevel wheel *C* beneath the platform, which carried seats arranged radially. Originally, these machines were steam driven, a portable engine driving the pulley by flat belt. In later years, an electric motor was often substituted. A clutch was incorporated in the irreversible worm drive to the oscillating movement; stopping the machine was effected simply by first declutching this motion when the axis was vertical, and then bringing the platform to rest by means of a friction brake. In this respect, the machine was an advance on the Savage device, in which several further circuits had to be made in the event of overrunning the landings, since the rotary and oscillating motions were inseparable.

Another ingenious amusement ride invented by Edward Amyes was the "Semi-Twister," or "Wiggle Woggle," of 1912. Again, quite a measure of success was achieved and several examples survived until recently. One is believed still to be in operation in Scotland. Six rows of seats, each accommodating five riders, were secured to a rectangular platform which remained in one horizontal plane, but was given a motion made up of two linear motions at right angles to one another. This was accomplished by fitting to the underside of the platform four flanged wheels which ran on a pair of rails fitted to a second (lower) platform, itself mounted on flanged wheels running on further rails, at right angles to the upper pair and

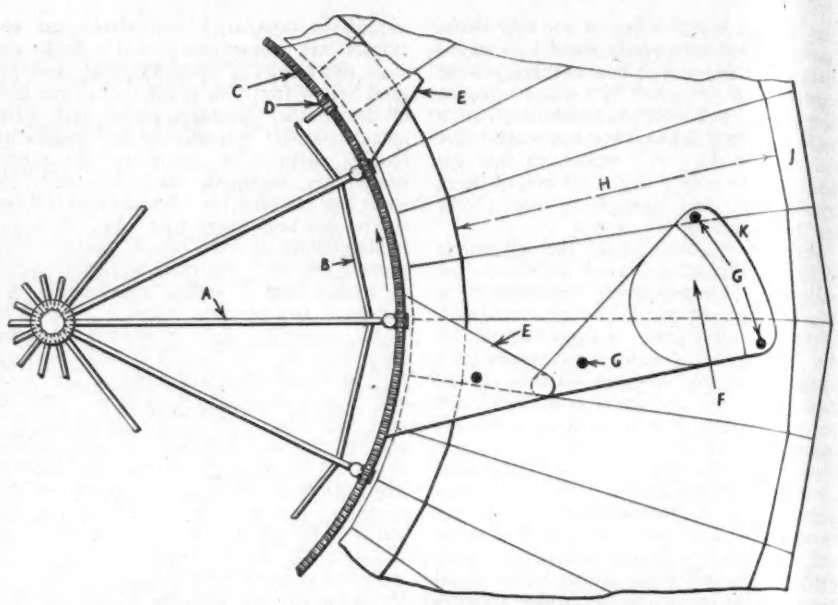

Fig. 21—The "Swirl" or "Skid," one of the first of the modern high-speed novelty rides

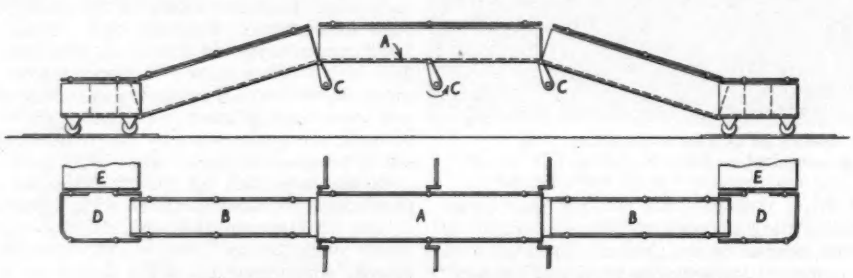

Fig. 20—The "Cakewalk" shown here in diagrammatic form was perhaps the most successful of crankshaft devices. Introduced about 1907

secured to the base frame. Centrally between the rails the base frame carried a vertical axis upon which ran a bevel gear driven by pinion and shafting from outside the machine. A crankpin on the face of the gear engaged in a bearing on the main (upper) platform, and so imparted to it the desired motion. Amyes undoubtedly recognised the necessity for simplicity in amusement devices intended for fairground use, and did not, for instance, try to incorporate a quick-return motion, planing machine fashion, in his "crankshaft" novelties. In any case, in the author's experience, his "Razzle-Dazzle" and "Wiggle-Woggle" are amply nauseating with merely a common crank.

Probably the most successful of all crankshaft devices, however, was the "Cakewalk," patented by Walter Taylor, engineer, of New Brighton, in 1907, and shown diagrammatically in Fig. 20. It was not a ride in the strict sense, but one of the small class of machines in which a hazardous course had to be negotiated, and which, of course, had the advantage of being continuous running, with no lost time unloading and reloading. A platform *A*, about 2ft 6in wide, had side walls surmounted by heavy handrails and was mounted on three sets of cranks *C*. Platform *A* was connected by two intermediate platforms *B* to end platforms *D*, which ran on wheels on rails. Walls and handrails surrounded the end platforms, except for an access opening adjacent to the fixed platform *E*. In practice the layout as drawn was duplicated; three shafts across the machine carrying opposed cranks at each end and the central shaft was electrically driven. Several examples of these machines are still in regular use, and are intriguing in that, despite the directly opposed crank setting (a necessity from the balance point of view), dead centre locking never seems to occur.

Within a year of Taylor's cakewalk patent Messrs. Thos. and J. R. Walker, the Tewkesbury roundabout builders, patented an alternative design. The equivalents of the two end crankshafts of Taylor's machine were replaced by plain shafts carrying T-shaped cranks, fastened to the shafts just below the intersection. The lower ends of the vertical arms were linked by means of connecting-rods to the central crankshaft, which ran continuously in one direction. The horizontal members of the "T" cranks hence formed rocking inclined planes, and all moved in unison. Rollers beneath the central section of the platform or walk rested on these rocking planes, which, needless to say, had stops at each end. Various means, including an air or oil dashpot and plunger device, were suggested to diminish jolting and shocks, but it is hardly surprising that the device found little favour. It has been established, however, that at least one full-sized example, having two "walks" and outwardly resembling a conventional cakewalk, was built.

It was seen in the second article of this series that the early steam-driven "dobby horse" roundabouts made use of the effect of centrifugal force, the horse anchorages being designed so as to allow of "swinging-out" to a limited extent. It was natural that one line of roundabout development should lie in the direction of a high-speed machine with unlimited "swing-out." Such machines first appeared as large semi-permanent devices in amusement parks, multi-seater carriages being suspended by wire ropes or chains from a revolving superstructure. The smaller fairground equivalent, known as the "chair-o-plane," was not seen in this country until the early 'twenties, when it was imported from the Continent in considerable numbers. It quickly became popular and is still frequently seen. The roller race for the spinning top is carried at a height of about 20ft from the ground on a suitably braced steel column; the top comprises a series of sixteen, eighteen or twenty radial swifts, tied by rods to an upper roller race in the same way as on an ordinary roundabout. An independently suspended chair accommodates each rider and is carried by two or four chains from a spreader beam or cage whose centre is pivotally attached to a swift. A circular platform surrounds the "pole" and has continuous steps; the height and diameter being so compromised that a spectator cannot be struck by a rider's feet. The driving gear is very simple: an electric motor drives by flat belt a short horizontal countershaft from which a pair of bevel gears drive the vertical shaft carrying the pinion of the top lantern wheel. A speed of

twelve to thirteen circuits per minute gives quite a reasonable "swing-out."

A few larger "flying machines" have appeared on the fairgrounds from time to time, some including means whereby the suspended cars can be raised and lowered before and after (or in some cases during) flight, but they are seldom seen nowadays. The only recent development of the idea has been the juvenile "chair-o-plane". This device, practically unknown ten years ago and now commonplace, amounts to a set of individual chairs suspended from the top frame of a normal electrically driven children's roundabout.

A machine combining the effect of centrifugal force with a measure of passenger control is the "Swirl," or "Skid," introduced to this country in 1929 or thereabouts, with almost immediate success. Many examples were built in pre-war years by R. J. Lakin, of Streatham, incorporating brake gear patented by him in association with Messrs. C. W. R. and John Thurston, the well-known East Midlands showmen. Since the war both Lakin and Orton and Spooner have produced examples, and the machine now ranks certainly fourth, and probably third, in numerical popularity of adult power-driven fairground rides. The essentials are shown in part plan in Fig. 21. The fixed centre consists of a series of braced steel frames *A* arranged in radial formation and spaced by members *B*. Horizontal and vertical rollers at the ends of the frames support and locate a heavy steel annulus *C*, about 20ft in diameter and having spur teeth, on its upper surface. It is operated by a central electric motor with a flat belt reduction drive to a countershaft carrying the pinion *D*. A series of heavy triangular plate frames *E* is bolted to the annulus. The cars *F* are pivoted to *E* as shown, each being mounted on three swivelling castors *G* which run on the steel-plated portions *H* of the horizontal segmental wooden floor *J*. Each car carries a seat *K*, surrounded by a tall seat-back; suitable handrail grips are also provided. The brake gear (the subject of the patent) is of pedal-operated "normally-off" pattern, and amounts to a friction block operating directly on to the steel floor plates.

The machine runs at high speed (eleven or twelve circuits per minute) and the cars assume a radial position unless and until the pedal is depressed. A violent forward lurch can be achieved by depressing and then suddenly releasing the pedal. "Swirl" machines are usually about 45ft or 55ft in diameter, with the floor in forty-two segments, and having either eight or nine cars. One motor is usual, but a few larger examples have two, the driving pinions being diametrically opposite one another. The annulus is made in four sections, and as a safety precaution is encircled by a strained double wire rope. For the same reason a heavy chain links each car to its plate frame. The "Swirl" does not lend itself to "centre truck" construction, and the working parts, many of them necessarily heavy, have to be dismantled for each move and manhandled to their stowage places in the trucks. In spite of this disadvantage, the machine remains extremely popular, and it is to the credit of the designers and manufacturers that many early examples are still in good mechanical condition after having been erected and dismantled perhaps hundreds of times. For some inexplicable reason "Swirls," alone among English-built circular rides, are almost always run anti-clockwise. The machine constitutes a difficult electrical load, since riders generally seem to depress the brake pedal while waiting for the start of the ride, and the starting current is consequently heavy.

This article may conveniently be concluded with the purely passenger controlled fairground machines—the "Dodgem" and the Speedway Track. The former first appeared in this country as an amusement park feature; portable versions followed in the later 'twenties and by 1939 the device was the most popular fairground ride in this country, a position it still retains. The two-seater cars are invariably three-wheeled, the single front wheel acting as a steering castor. Motor, reduction gearing, and front castor form a self-contained assembly, turning as a unit under the control of the steering wheel. Current is taken from overhead wire netting by a spring wiper attached to a vertical pole at the rear of each car, the return being via the steel floor, which is entirely surrounded by suitably sprung bumpers. During the progress of the ride, each passenger controls the motor of his car by a simple pedal-operated "normally off" spring switch. No vital changes have been made in "Dodgem" car design since the universal adoption of front-wheel drive, but detail improvements are continually being effected.

Portable "Dodgem" tracks are made with a sectional steel-plated floor in sections about 7ft 6in by 4ft. A track width of about 40ft is usual; lengths vary from 60ft to 85ft, with very occasional longer examples. Sixteen cars can reasonably be accommodated on a 40ft by 60ft track. An ingenious roof truss layout (timber built in pre-war days, but nowadays of light metal sections) supports the wire netting frames, and leaves the floor area completely clear.

The Speedway Track, like the "Dodgem," was at first an amusement park device, and employed miniature petrol-driven cars. Travelling versions of this ride never achieved very much popularity, although still occasionally seen. Electric drive, when perfected, changed the situation completely, and the "Monte Carlo Rally," as it became known, gained rapid popularity at the fairs of the late 'thirties. The track sections comprise alternate wide steel and narrow wooden strips mounted on cross bearers. The metal sections are alternately positive and negative. Two collecting wipers are attached to the track-rod of the steering gear of each car, which is of conventional Ackermann layout. A long central island on the track compels drivers to follow a roughly elliptical course, and in practice it is possible to pick up current almost continuously, and thus attain a high speed, by a sharp deflection of the steering immediately the supply is lost. The absence of overhead current collectors means that the track can be superelevated, which it almost invariably is. Track lengths vary, and, as with the larger of the "Dodgems," the fastenings are so arranged that a lengthy track can be erected with some sections omitted if space considerations on certain sites so demand.

Apart from novel track layouts, future development of this class of device seems likely to lie in the direction of further car improvements.

(To be continued)

Training of Engineering Designers

By EWEN M'EWEN

In our issue of May 22, 1953, we reprinted a lecture by the author of this article upon much the same subject. This present article is critical of the existing system by which nearly all brighter lads, from whatever stratum of society are "drafted" to a university by the State, and of the tendency of universities to lay so much stress on mathematical ability in the training of engineers that potential designers may be frightened away. The author suggests that universities should pay better attention to the training of designers and that design ability should be recognised in the degree pass list. Finally, some observations are made upon the attitude of industry to potential designers.

PERHAPS the most important point that I want to stress is the reason why it is that what the universities are doing to the engineering undergraduate is of importance to design in the engineering industry and why it is that you can no longer just say that the best designers do not come from the ranks of the university graduates: those of you who have read the report in THE ENGINEER of my lecture to the North Eastern Branch last May must bear with me if I stress this vitally important matter. In summary, the position is that in the present circumstances of education, it is difficult for the reasonably bright boy to avoid entering the university: he is drafted there by the Welfare State. The following figures are from Dr. Ashby's address to the F.B.I. Conference:—

	1912		1951
Boys reaching eighteen, total	397,700	...	305,700
Number of honours degree standard	34,200	...	27,500
Number of good honours standard	19,000	...	15,300
Number entering universities	4,000	...	16,500

What this means for the recruitment of designers for industry is a lowering in the standard of those who enter the D.O. straight from school, not by an overall reduction in ability but, which is far more serious, by having skimmed off the cream; this cream, which is sent to the universities, is that very part from which the designer brought up in the works has been recruited in the past.

I have indicated that had the university selection system been perfect in 1912, 21 per cent of the first-class or 11½ per cent of the good brains, would have entered the universities; in 1951, the proportions would be 100 per cent and 60 per cent, respectively. In addition, the selection system is probably better than it was forty years ago and people are continually striving to make it better and better so that none that can profit by university education shall be denied it (unless the father earns £1500 a year and has three children, but that is another matter). I am not happy with these "improvements." Educationists seem to regard it as a loss to the nation if a bright boy goes into a works as an apprentice rather than straight to the university, so that it is becoming progressively more difficult for a good lad to serve his time first and then go up higher into the D.O.—or into the university. The proportion of undergraduates with any practical experience, which had shown a welcome rise, will thus continue to fall, making correspondingly more difficult the provision of worthwhile design courses in the degree curriculum.

One of the weaknesses of the straight from school to university procedure is that the lad will often read subjects because he has been told to rather than because he is interested in them. He won't have much

idea of what engineering is about, at any rate unless he comes from a markedly engineering family and his school studies will have been, naturally, either arts or pure science subjects. If he has shown great ability in mathematics and physics he may be advised to read engineering, but more probably will be advised to read physics ; more moderate achievement in the same subjects generally leads to the engineering school ! But the man who will make a brilliant designer, the man with a really creative mind, will not necessarily be outstandingly good at these shibboleth subjects. I do not, of course, deny the need for analysis in design, or decry the ability of designers to apply the limited mathematics that are usually necessary in the check analysis of their creations ; but I do stress that such men need not, and often will not, have outstanding mathematical ability. At school their best subjects may have been those giving the maximum scope for creative talent : English, music, drawing. Bring forward a boy who has excelled in these and most people would put him into the arts courses to make a schoolmaster of him ; his own experiences of mathematics make him reluctant to trust his future to his ability to master its enigmas. Put the same lad into an engineering works as an apprentice and he is a success ! He shows manual dexterity, as a rule, and when he arrives in the D.O. it is soon obvious that he is able to think out for himself a creative solution to the problem. Of course, at first, his schemes will be unworkable for lack of practical experience, or for reasons which become apparent on analysis; but undaunted, he produces others.

I am frightened by the belief that we miss many or most of the potential designers in the university intake. C. F. Kettering of G.M. said a year ago : " All the kids in our schools are getting afraid of our engineering courses because they think that some fellow can turn a key and ask them a question in mathematics and he's flunked out. And that is why he studies economics or business management, because they haven't any trick questions like that in their courses yet. That is the reason we are 34,000 engineers shy, because there are thousands of kids who would like to be engineers but they are simply afraid of that differential equation or that integral sign. Now, let's explain to them what it is. It isn't nearly as bad as it looks, but let's tell them that there is only about 10 per cent of engineering that can be calculated and the other 90 per cent you have to do by experimental work." He might have added " or by design flair and creative ability." " A mechanical engineer," said Geo. McMillan, also of G.M., " is a person who poses as an exacting expert on the basis of being able to turn out with prolific fortitude infinite strings of incomprehensible formulæ calculated with micrometric precision from vague assumptions which are based on debatable figures taken from inconclusive experiments carried out with instruments of problematical accuracy by persons of doubtful reliability and questionable mentality for the avowed purpose of annoying and confounding a group of fanatics referred to as engineering designers."

It will always be difficult to select satisfactorily from those who have not specialised in pure and applied mathematics, physics and chemistry at school, those who are, nevertheless, potential engineers. But I think that the effort is very well worthwhile, since amongst these non-specialists are likely to be found some of the best design potential. For a start, then, I think we should abolish faculty and departmental requirements over and above the university matriculation agreed level. (I think that this has been made excessive, but again that is another question.) When the immediate post war bulge of university candidates was heavy upon us there was a tendency for engineering faculties to require special additional or restrictive requirement in matriculation, such as that mathematics at advanced level would be a prerequisite to admission to an engineering department. I do not think the general performance in the later years has been much improved by this additional hurdle, and I am certain that it has debarred good candidates.

Next, what are we going to do with those who do start on engineering courses so far as design is concerned ? Let us first recognise (with Mr. Hugh Clausen) that " drawing is the engineer's language, the only valid medium for the transfer from thought to material. The engineer who cannot draw or sketch is like a business man who could not write, or even speak." Mechanical skill on the drawing board is a dexterity not to be despised : good draughtsmanship should be so ingrained as to require no conscious effort. Of course, the majority of the students will not have done any engineering drawing before, so that quite a large amount of time must be devoted to it, particularly in the first post-intermediate year. At this stage we can no more teach design than the elementary school teacher can teach literature to those still in the stage of acquiring mechanical skill at reading and writing. In the next year a start can be made on detail design problems. This is not just because it is easier to devise them than to supervise a major scheme but also because the designer should realise the importance of attention to detail. And at this stage we should be prepared to recognise that design merit is at least as great an asset as mathematical ability and should be correspondingly rewarded in the pass list. In the final year, I hope that we shall see more flexibility and choice of courses for mechanical engineers generally ; a degree design might be undertaken by all with advantage but for those with the right bent this might be their special option instead of (say) thermodynamics as the special topic.

It was abundantly clear from the correspondence in THE ENGINEER after my last talk on this subject that many engineers in industry question the competence of university staffs to teach design. As a matter of fact, I agree with them ; very few lecturers have either the necessary flair or the right kind of experience. But this could be remedied if we looked for just those qualities in a proportion of the men we appoint instead of the present emphasis on research and publication in every case. Such men must be able to practice as consultants, so keeping in touch with real problems as do teachers of architecture (I declare my interest : as a practising consulting engineer in a university post I naturally regard this as an ideal arrangement). And industry might profit considerably by putting some of their design problems to university staff : many would not lead to anything remarkable but every now and again a really worthwhile and original design would result to their mutual benefit. Once such an idea " caught on " the supply of real problems on which the student could cut his teeth would be assured !

So much for the university end of the problem. Now suppose young Bill Brown, who has just graduated with special commendation in design, were to come to your firm. Clearly, he would have to find his way around, learn the limitations and good points of the available plant, absorb the background of valuable experience accumulated by his colleagues in the drawing office. Then, after two or three years, he begins to be a real asset. So the management reward his abilities by making him a departmental manager, or put him in charge of an area sales office ! When I was working on a board, I complained to the G.M. that another man of less qualifications and equal seniority who was on the sales staff was much better paid and was told in reply : " Yes, of course ! But think what an interesting job you have got ! " So long as the D.O. is a good place to have been through, without adequate reward for the outstanding man who remains in it, so long will many of the best brains leave it to contain only the second-raters or those with an overwhelming vocation who will give up all worldly reward for the sake of doing what they want to do. True, the man with a vocation is an asset beyond price, but that is no reason for not paying him as adequately as possible.

I believe that the most important step in the training of engineering designers in industry is to make it worth while to be a good one ! It is time we realised that creative ability is not given to all, but that in fact good potential designers are but a small minority of the population and that having got one who has developed beyond the chrysalis stage we should make it very much a rewarding career for him. No doubt many good designers would make good departmental managers or good salesmen but the potential supply of these is much greater and, in any case, even if the best razors are better for cutting grindstones than inferior cutlery (as Kipling said) it is still a waste. I have been told that if the salesmen aren't up to their job there won't be any orders to design for. Maybe ; but if there aren't any designers up to their job the firm will go out of business whatever the salesmen do !

Having spent some time in industry, I hold strong views on some of the procedures which might be adopted in training within the firm, too. Any apprentice with a glimmer of design ability should be given a good run in the D.O. You don't have to issue his drawings to the shops if you don't want to, you know ! And he should be given the chance to try real design problems and not just act as a cheap detail draughtsman. Generally he will be a bad one anyway, as his lack of experience will lead to calling from wrong limits, &c., or omitting vital information, and it is my recollection that checking the details drawn by an erratic apprentice can take considerably longer than it would do to make the drawings oneself. Encourage him to take the right kind of evening courses : he may profit far more from attending a course in architecture than one in works management and organisation. Put him with your best designers, especially the older men. Too often we have to relearn things that our senior men had learnt long ago when they die or retire because they have left no record and passed their knowledge on to none. Send him into the shop to explain to the foreman patternmaker or the departmental foreman what was intended and let him profit by their blistering comments : he will learn quicker that way than any other what is in fact feasible. And, above all, make the D.O. a place which it is his ambition to adorn permanently. This is not only a matter of pay, although I have already stressed the importance of that, but of amenities, and even—dare I say ?—privileges. Send your young designers to the engineering exhibitions at the firm's expense. Send the senior men—and occa-

sionally a junior as an especial reward—to the International exhibitions abroad. They will be cheap at the price.

To conclude, I plead for recognition of the importance of the engineering designer and for his better reward; for more stress on design in engineering curricula, for the recognition that synthesis is not only more difficult but also more generally necessary than analysis. The tendency nowadays is to try to produce a race of engineers who cannot draw and to neglect the creative side so that the best men are drawn into other activities. If we are to survive we must not only pay attention to productivity but to the quality of what is to be produced: the designer is the key man.

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Lackenby Open Hearth Steel Works

No. II—(*Concluded from page 193, August 6th*)

The post-war programme of steel works development which is being carried out by Dorman, Long and Co., Ltd., was planned in three stages. The second stage, which has now been completed, includes the erection of an open hearth steelmaking plant on the Lackenby site of about 680 acres. The plant has been designed for an annual ingot production of 625,000 tons. Here we conclude a description of the melting shop and other buildings and of the equipment installed in them.

Travelling Cranes and Furnace Chargers

THE three ladle cranes with which the casting bay is equipped are each of 160 tons capacity, with a 30-ton auxiliary crab, and carry a ladle of 120 tons capacity. Their span is 75ft. In the same bay there are three semi-portal ladle teeming carriages of a somewhat unusual design, having one rail over the teeming platform and the other on the casting bay floor, outside the teeming road. These machines can carry a ladle, which has been placed on the carriage by the ladle crane, the full length of the shop, and place it over any mould for pouring. The teeming carriages have electrically driven long travel and cross traverse motions which are pendant controlled from the teeming platform, the cross traverse being 5ft 3in. To avoid having to lift the ladle over the frame of the traversing trolley, the frame is made in the shape of a horizontal "U"; from the two sides there hangs a cradle on which the outer ends of the "L"-shaped ladle bearer girders sit.

Most of the pouring is done from these teeming carriages, thereby releasing the three ladle cranes for other duties. One of these duties, not generally performed in the casting bay, is transferring iron from the mixers into the furnaces. The handling of all hot metal in the casting bay thus obviates the need for a hot metal crane in the charging bay, and has permitted the use of overhead revolving chargers. With very large furnaces, an important factor in the efficiency of the melting shop is the length of time spent on a general furnace repair, and this time can be greatly reduced, of course, if the stage is kept clear for the work of the bricklayers and for their materials. The overhead revolving charger certainly has the advantage of being clear of the stage, but it cannot be used efficiently if the hot metal crane is also in the charging bay. Four overhead charging machines, of 6 tons capacity and with a span of 65ft, have been installed at Lackenby, each of them having a 10-ton auxiliary trolley running on the same girders as the main trolley. The speeds of the various motions on these machines have been chosen to make it possible to charge boxes into the furnaces at a continuous rate of one box a minute. The size of the furnaces and the length of the charging box benches, however, allow two chargers to work together at one furnace.

In the stock bay there are four high-speed magnet cranes, of 65ft span and 20 tons capacity. The magnet on each crane is slung by its three chains from a spider, to which are anchored three hoist ropes, wound on two barrels geared together. This method of suspension has been designed to eliminate the swing of the magnet, and is expected to reduce considerably the damage suffered by wagons when scrap is being unloaded. Lime and limestone in boxes which are stacked on pallets each holding four boxes (Fig. 5) can be lifted on to the bench by a lifting beam, which clips on the magnet and carries four hooks for the pallet. Running across the melting shop over the ladle crane and charger gantries, there are three 7½-ton crane repair trollies. They are remotely controlled from three platforms reached by stairs from the gantry girders.

Materials Handling

The incoming materials for the Lackenby steelmaking plant are carried in trains of wagons about 550ft long and are moved from the exchange sidings by the works' locomotives into two sets of sorting sidings situated to the east of the main plant. One set of the sidings is used for scrap and ore and the other for the remaining furnace charging materials and for dolomite. The two sets of sidings, comprising eighteen standage roads, can accommodate 700 wagons. From the south end of the sorting sidings scrap, ore and scale are drawn into a shunting neck at the extreme south end of the melting shop building and are pushed up a ramp to the stock bay stage. Along one side of this stock bay there is a bench holding the furnace charging boxes, which are refilled by overhead magnet cranes as they are emptied into the furnaces by the overhead charging machines in the adjacent charging bay. The level of the rail tracks in the stock bay is such that the top of the average wagon is brought approximately level with the top of a charging box standing on the bench. This arrangement was illustrated on Plate 3 in our last issue. Molten metal, from the blast-furnaces at the Dorman Long Cleveland and Redcar works, is brought to the casting bay in ladles holding 70 tons. In the bay the ladles are picked up by the ladle cranes for pouring the hot metal into the mixers (Fig. 4).

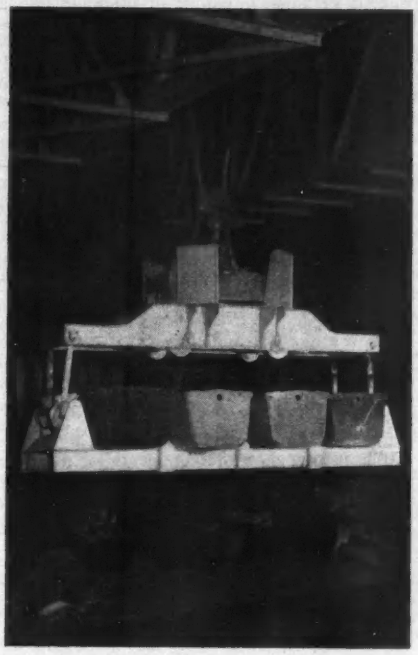


Fig. 5—Lifting beam and tray with lime and limestone pans handled by the stock bay magnet crane

The unloading, stocking and handling of the furnace raw materials—other than scrap, pig iron and scale—has been given special consideration in designing the plant. A separate building 270ft in length, with a crane span of 65ft, which is situated on the east side of the melting shop, houses plant from dolomite crushing, lime and limestone stocking, preparation of mortar, fireclay and tarred dolomite, ferro-manganese crushing and the storage and handling of other furnace materials such as anthracite and ferro-alloys.

For the first two of these operations a special handling plant enables the three dusty materials to be discharged from wagons, tipped into storage bunkers, and led to the final feeding points, all within dustproof enclosures. On one side of the building a wagon tippler discharges railway

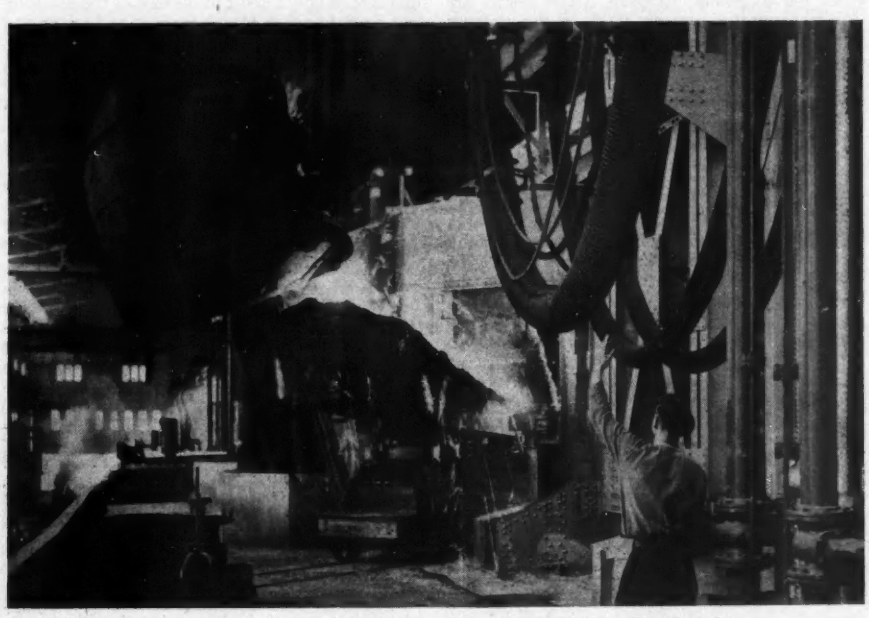


Fig. 4—Charging one of the mixers with hot metal. The ladles have a capacity of 70 tons

wagons of lime, limestone or dolomite into a hopper, from which it is raised by twin skips travelling on a combined hoist and runway covering three bunkers, one for each material. The tipping of the wagon takes place in an enclosure formed by the tippler cradle, a curved hood and end shields. From the storage bunkers lime and limestone are carried by two further skips, travelling on combined hoists and runways across to two small service bunkers, one for each material, at a high level adjacent to the east side of the stock bay. Each of these bunkers is equipped with a retracting belt feeder, which fills the charging boxes one by one as they are hauled on their wagons past the filling point by a wagon haulage gear fitted between the rails and pulling on the wagon axles. The two service bunkers hold 50 tons each, and the stock bay rail track has accommodation for forty wagons, or 160 charging boxes, so that the available stock in the melting shop, when all the boxes are full, is over 300 tons. The lime and limestone handling plant has been designed to deal with the whole of the melting shop's requirements for the three shifts, while working on one shift only. The portion of the melting shop stock bay containing the lime and limestone feeders is illustrated in Fig. 6.

Dolomite is fed from its storage bunker into a swing hammer mill. After crushing, a bucket elevator delivers it into a bunker of 90 tons capacity, from which portable bins can be filled by means of a belt feeder. The bins are simply the top hoppers from the fettling machine, enlarged to hold about 4 tons of dolomite. They are carried from the materials handling plant bunker across to the two furnace stage service lifts by fork-lift trucks of 12,000 lb capacity. In addition to the main enclosure of the lime, limestone and dolomite handling plant, extraction hoods are provided at all filling and feeding points, where falling material may be expected to cause a dust cloud, even if the point is already inside the main enclosure. The hoods are connected to a bag filter dust collecting and separating plant enclosed in cabinets, with automatic shaking mechanism. The remaining furnace materials which are stored and processed in this building are brought in on a high-level rail track and stored in open bunkers below the rail gantry. For fireclay, mortar and tarred dolomite, three 9ft pan mills have been provided. The various ferro-alloys are carried to the stage service lifts by the fork trucks in bins of 3 tons capacity. These trucks also carry fireclay and tarred dolomite in skips, and anthracite, already made up in bags, on pallets.

Outgoing Materials

The outgoing materials from the Lackenby steel plant, consisting, of course, almost entirely of ingots and slag, flow in the opposite direction from the incoming materials. The ingots are drawn from the teeming stage to the stripper building at the south end of the plant, alongside the ramp leading up to the stock bay. The stripper building (illustrated on Plate 3 in our last issue) is 280ft long and has a crane span of 88ft 6in. It is equipped with two stripper cranes of 6 tons ingot capacity, and a 20-ton ingot and mould handling crane. Hot ingots for transport to the Cleveland and Redcar works are loaded into transfer cars and are hauled, in trains of about 150 tons of ingots, on to the link line. As the ingots destined for the Britannia and Acklam works have to be transported over the British Railways system from the east to the west of Middlesbrough, they are first allowed to cool and are then loaded into railway wagons and hauled over a weighbridge to the exchange sidings.

For breaking up ladle skulls, old ingot moulds and other heavy scrap a gantry has been built at the north-east corner of the plant. It carries a magnet crane of 40 tons capacity, with two hoist speeds, 30ft per minute for heavy lifts and 120ft per minute for general work. Breaking is done by a 10-ton ball, which is dropped a distance of 40ft into a circular pit in which the scrap has been previously placed. The pit is lined with old ingot moulds filled with concrete, and keyed together with a lattice of steel bars.

For furnace slag, a separate railway connection to each furnace and mixer runs underneath the high-level stock bay. The filled ladles are hauled out by a locomotive on to a common track on the east side of the shop and pushed up a slag bank lying parallel to the common track and about 200ft distant.

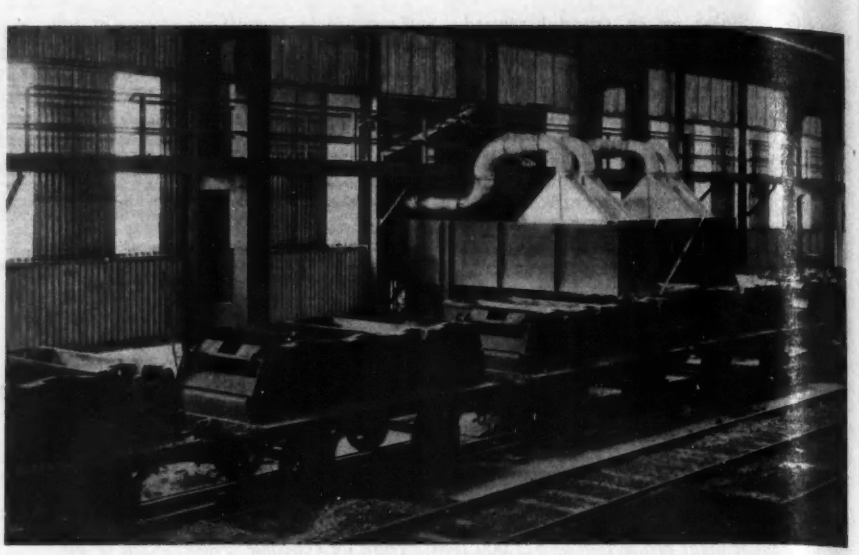


Fig. 6—Part of the melting shop stock bay containing the lime and limestone feeders

Between the exchange and the sorting sidings all traffic passes over the main incoming and outgoing weighbridges, lying to the north-east of the works. The two weighbridges are on parallel tracks, with a common weigh-house. Both have twin platforms, giving a weighing length of 36ft. The outgoing weighbridge is of 75 tons capacity, but the incoming weighbridge, which has been designed to act as a standby for the hot metal weighbridge at the Cleveland blast-furnaces, is of 150 tons capacity, thus enabling the weighing of a 70-ton ladle, together with its carriage. In addition to the comprehensive railway system, there is a good road system giving access for lorries, cars and trucks to every building.

Basic Slag Plant

The blast-furnace metal which is used at the Lackenby furnaces contains a high percentage of phosphorus, and as the steelmaking process produces a basic slag suitable for agriculture, a crushing and grinding plant, capable of producing 2500 tons per week of ground slag, has been installed. This plant will not only grind all the suitable slag from the Lackenby furnaces, but also deals with fertilising slag produced at the company's other furnace plants. The slag bank lies parallel to the melting shop, and a distance of about 200ft to the east of the common rail track to which all the furnace and mixer slag tracks are connected. Slag from the furnaces is therefore only hauled an average distance of a little over half a mile. The slag bank has a usable length of 1100ft and a tipping height of 18ft. The furnace slag, brought in ladles of 235 cubic feet capacity, is tipped progressively along the bank and allowed to cool and disintegrate.

Sufficient tipping length and height is available to allow the slag to lie for two or three weeks, after which it is loaded by a 1¼ cubic yard diesel-driven excavator into dumpers, which carry it to the primary hopper. Before being crushed the slag passes over a roll screen and a picking table, where steel scrap is picked out and thrown aside for collection and return to the furnaces. The screened and crushed slag is raised by a skip hoist to the crushed slag bunker, of 300 tons capacity sufficient to allow the crusher to work on one shift only, while grinding takes place on two shifts. Grinding is done in a compound ball mill of three compartments, after which the slag passes into one of four containers, each of 70 tons capacity, where it is held until a sample has been analysed. It is then blown by compressed air either into one of four silos, each holding 900 tons, or to an automatic bag packing machine.

Rolling Stock

As the Lackenby works is a self-contained plant, it has had to be equipped with a considerable amount of rolling stock, such as locomotives, wagons, ingot cars and slag ladles, for the transport of the various materials along its 24 miles of railway track. All the locomotives are steam driven. Two sizes of standard industrial locomotives have been provided, one of the 0–6–0 type with 18in by 24in cylinders, for the main traffic duties, and a smaller 0–4–0 engine with 16in by 24in cylinders, for general yard work. In addition, two fireless locomotives are used in places where smoke would be a nuisance, such as below the charging stage, where the slag ladles are hauled out from the furnaces.

Four kinds of wagons have been provided to handle internal traffic. There are steel-bodied box wagons, of 16 tons capacity, for general use; flat-topped wagons, with similar underframes to the box wagons, for transferring boxes of lime and limestone on pallets along the stock bay; ore wagons of 40 tons capacity for transporting ore for the steel furnaces from the Cleveland works, and side-tipping wagons of 25 tons capacity for debris.

The ingot casting cars are of welded steel plate construction, with roller bearings integral with the wheels. They are designed to carry a maximum load of 80 tons on two axles. The slag ladles are of 235 cubic feet capacity, each ladle being carried on a four-wheeled carriage of riveted plate construction. Tipping of the ladle is by wire rope from the locomotive, after the carriage wheels have been chocked. For transporting the hot ingots over the company's link line to the Cleveland and Redcar works there are a number of special transfer cars. They have cast steel bodies, each on four wheels, identical with those used on ingot cars. On the body is bolted a frame of structural steel sections, to form a box in which eight 4-ton ingots can stand upright. Five of these cars form a train, carrying 160 tons of ingots.

Services

Coke oven gas to permit the furnaces and mixers to be fired with a mixture of gas and fuel oil is brought from the Cleveland works in an underground cast iron 24in diameter main, connected at the melting shop to a steel main supported below the charging stage. There are 12in branches to each furnace and mixer. Gas burners on swivelling arms, for drying out the casting ladles, are attached to the tapping platform stanchions. The general steam supply, for oil heating and atomising, for space heating in the offices and engineering shops, and for power generation, is raised from twin drum waste heat boilers (Fig. 7) at each furnace and mixer. Each boiler can generate 12,800 lb of steam per hour at a pressure of 250 lb per square inch, superheated to a temperature of 540 deg. Fah. The boilers are supplied with heated and de-aerated feed water, part of which is returned condensate heated by pass-out steam from the power generator, and the remainder town's water passed through a base-exchange softener.

Electric power is generated by a 5000kW

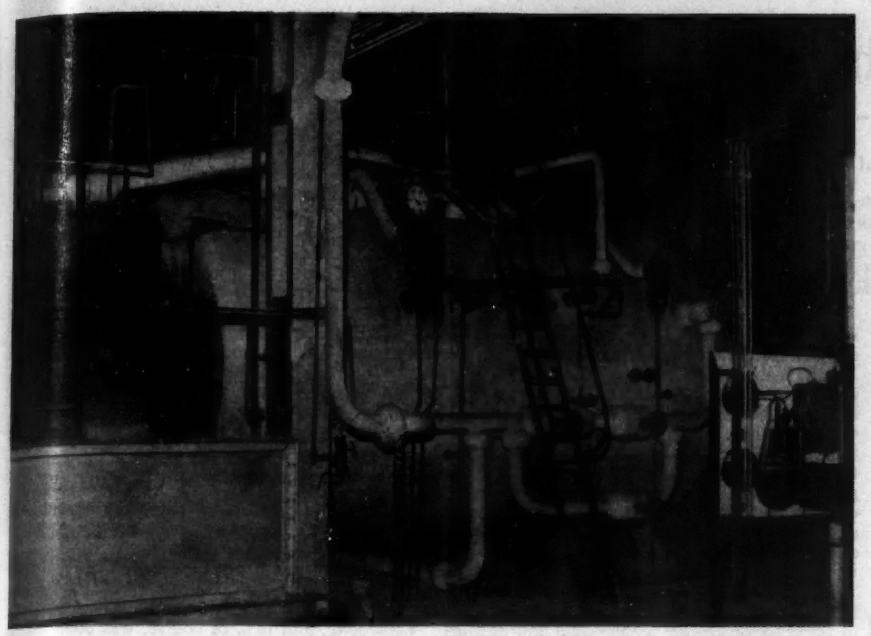


Fig. 7—Twin drum waste heat boiler. There are seven boilers, each generating 12,800 lb of steam per hour at 250 lb per square inch

turbo-alternator at 11kV, 50 c/s. Steam from the turbine can be passed out at 35 lb per square inch for space heating and for heating the boiler feed water. The turbo-alternator is installed, together with the furnace cooling water pumps, in a small power station, which also houses the main works electricity substation. Close by is the concrete cooling tower, 100ft in diameter, divided into halves for ease of cleaning. The base tank of the cooling tower has a capacity of 500,000 gallons, to give a reserve supply of water in the event of a shortage of make-up from the town's main. For the cooling water service, a common system has been installed, serving both the turbo-alternator and the furnaces. Water from the cooling tower sump is pumped through the condenser by its circulating pump and delivered direct into the suction header of the furnace circulating pumps which send the water, in a closed system of pipes under pressure, to the furnaces and back into the cooling tower. There are two electrically driven furnace pumps, each with a capacity of 4500 gallons per minute, and a steam turbine driven standby which is automatically started up by a fall of pressure in the delivery main and which remains in action until its automatic valve is reset. Provision has been made in the system for surge tanks and connections to compensate for any lack of balance between the requirements of the condenser and the furnaces. The supply and return ring mains to the furnaces are 24in diameter, and are connected to both the north and south ends of the plant, with valves suitably placed to allow either the north or the south section of the main to be shut off in the an emergency.

The hydraulic power for the furnaces and mixers is supplied by three centrifugal pumps, each capable of delivering 300 gallons per minute at a pressure of 800 lb per square inch. Because the demand for hydraulic power by a battery of steel furnaces is very variable, fluctuating within a few seconds from zero to possibly over 600 gallons per minute, the pumps work in conjunction with an air loaded hydraulic accumulator of 400 gallons capacity, on which the controls will start up successive pumps as required. The hydraulic pumps and accumulator, the boiler feed pumps and water treatment plant, the furnace fuel oil pumps, and the evaporators for the plant oxygen service, are all placed in a common house to the east of the main plant and connected to it by a pipe bridge carrying all the service pipes. The house is divided into sections for the various services and on its flat, concrete roof are the two supply tanks, one for boiler feed water and the other for the hydraulic pressure system.

The main incoming power supply to the Lackenby works is at 11kV, from the North Eastern Electricity Board's system, with connections to the power stations at the Dorman Long Cleveland and Redcar works, to give an integrated system. This supply terminates at the 11kV switchboard in the Lackenby power station, to which is also connected the 5000kW turbo-alternator. In view of the area of the Lackenby works, it was decided to establish inside the works a primary distribution network at this voltage, connected to four transformers. Three of these, each with a rating of 3500kVA, are situated respectively at the power station, the east side of the melting shop, and the basic slag plant. They are of the three winding type, giving power at 2750V and 440V on the secondary side. The remaining 1000kVA unit transforms down to 440V and is located in the substation at the engineering shops. Power at 2750V is used for all a.c. motors of over 100 h.p. These motors are all squirrel cage, with direct-on-line starting, and include the motors driving all the large circulating and hydraulic pumps and the fans at the waste heat boilers.

For all the overhead travelling cranes, except three isolated ones, two of which are only lightly used, direct current at 230V is employed. To serve the cranes in the melting shop, rectifiers, comprising two 600kW banks, have been installed at the power station. The cranes in the engineering shops and the stripper building are supplied from rectifiers at the engineering shop substation.

Engineering Workshops and Administrative Buildings

Well-equipped engineering maintenance shops have been provided on a space 1000ft long and 300ft wide. These shops are grouped round an open gantry of 88ft 6in crane span, which carries a 20-ton overhead crane ; under this gantry will be placed castings and forgings awaiting machining and large spares which need not be kept under cover. The gantry is 300ft long, but can be extended in length to over 700ft if this is found necessary in the future. The machine shop is at right angles to the gantry, and consists of two parallel bays, 60ft wide by 230ft long. The heavy machine and fitting bay is spanned by a 40-ton overhead crane, capable of handling the heaviest machined components in the works and of dismantling a steam locomotive ; in the light machine bay there is a 10-ton overhead crane. Across one end of the two bays are two parallel rail tracks, which accommodate locomotives, travelling jib cranes and ingot cars undergoing repairs.

The light machine bay is at present partially occupied by the electricians' shop, which will be moved to a new building alongside the central gantry when the necessity arises. Offices and a toolroom occupy an annexe running the full length of the heavy bay. Provision has been made for a third main bay, of 60ft span, in the future. Along one side of the central gantry are the smithy and boiler shop, each occupying half of a building 200ft long.

The main stores and the locomotive running shed are also on this side of the central gantry. The wagon repair shop, which also houses the woodworkers, has been placed close to the main sorting sidings, so that damaged wagons can easily be run into the shop for repair. This shop, 180ft long by 80ft wide, contains a 7½-ton semi-portal crane, covering two railway tracks, for wagon repairs.

All the brick buildings at the Lackenby works have been designed by the technical staff of Dorman, Long and Co., Ltd., and in order to give a unified appearance all follow the same general architectural lines. The largest of the brick buildings is the main administrative block, a three-storey building placed opposite the south-west corner of the melting shop, to which it is connected by a footbridge from the third floor, leading direct to the furnace stage. This footbridge has a walkway 7ft wide and also carries service pipes and electric cables. The building contains, in addition to all the clerical and administrative accommodation required for the works, welfare facilities for the melting shop personnel, and the works and stage laboratories. As the laboratory is too far away from the furnace stage to allow samples to be carried, and the analyses returned by hand, it has a twin pneumatic tube connection to the point between the mixers where samples are prepared.

Other welfare buildings have been provided at the engineering shops, the hydraulic and boiler feed pump house, and the basic slag plant. All these buildings have washing and lavatory facilities, steam-heated clothes lockers and mess rooms. The canteen provides hot meals for staff and workmen and has ample facilities for the preparation of snack meals for men who cannot leave their place of work during the shift.

Main Contractors

The majority of the design and construction work for the steel buildings and the furnaces and mixers was carried out by Dorman, Long and Co., Ltd., which also manufactured all the railway track and sleepers, wagons, and casting and slag ladles. The site preparation and other civil engineering work was shared by Lintzgarth Ganister Company, Ltd., Holst and Co., Ltd., A. Robinson (Contractors), Ltd., Wm. Press and Son, Ltd., and J. W. Pearson and Co., Ltd.

The following is a list of contractors for the major items of plant : *Mechanical*—Henry Berry and Co., Ltd., tilting cylinders for furnaces and mixers ; Summerson Foundries, Ltd., port end lifting cylinders ; Darlington Forge, Ltd., furnace rollers and charging bars ; Blaw Knox, Ltd., fettling machines ; The Wellman Smith Owen Engineering Corporation, Ltd., melting shop and stripper building cranes ; Babcock and Wilcox, Ltd., furnace charging machines ; Joseph Booth and Bros., stock bay cranes ; Strachan and Henshaw, Ltd., Edgar Allen and Co., Ltd., Bradley and Craven, Ltd., materials handling plant ; George Kent, Ltd., and Foster Instrument Company, Ltd., furnace instrumentation ; Spencer-Bonecourt, Ltd., waste heat boilers ; F. L. Smidth and Co., Ltd., basic slag plant ; Andrew Barclay, Sons and Co., Ltd., and R. Stephenson and Hawthorns, Ltd., locomotives ; Newton Chambers and Co., Ltd., slag ladle carriages ; Robert Hudson, Ltd., ballast tipping wagons.

Electrical Equipment—Metropolitan-Vickers Electrical Company, Ltd., A. Reyrolle and Co., Ltd., British Thomson-Houston Company, Ltd., Bruce Peebles and Co., Ltd.. C. A. Parsons and Co., Ltd., The General Electric Company, Ltd., Brush Electrical Engineering Company, Ltd., and English Electric Company, Ltd.

Hydraulic and Steam Services—Brightside Foundry and Engineering Co., Ltd., Davenport Engineering Company, Ltd., Davy and United Engineering Company, Ltd., and Mather and Platt, Ltd.

Indian Journal on Irrigation and Power Developments.—A monthly journal devoted to irrigation and power developments is now published by the Central Water and Power Commission of the Government of India. It is entitled *Bhagirath*. Bhagirath is credited in Indian mythology with having made unwearying efforts to bring the Ganga into the plains of India and to conduct its course to the sea for the resurrection of his ancestors. The Ganga is also known as the Bhagirathi and the expression "Bhagirath Prayatna" (the labours of Bhagirath) has become proverbial in Indian languages for the herculean effort needed for such tasks. The first issue of the journal—for June—contains information on various Indian river development schemes, the principal article being on the Bhakra-Nangal project.

Research into the Properties of the Hydrogen-Oxygen Cell*

By F. T. BACON, M.A., A.M.I.Mech.E.

In this survey of work on the hydrogen-oxygen cell, the author describes the principles of operation of the cell as a means whereby the free energy of combustion of the fuel (in this case hydrogen) can be converted directly into electrical energy. He reviews the various kinds of cells that have been investigated and outlines the unsolved problems and the proposed applications.

A "FUEL CELL" is generally understood to be an electrochemical cell in which the free energy of combustion of a fuel is converted directly into electrical energy. Among the many forms of fuel available, hydrogen gas is particularly suitable for use in a fuel cell. The problem, therefore, is how to cause the electrochemical combination of hydrogen with oxygen at suitable electrodes, the current being carried between the electrodes in an electrolyte.

Study of the work done by various experimenters in the field of "fuel cells" led the author in 1932 to conclude that the time was ripe for a renewed attack on the problem. All the available information on the subject was collected, and a search was also made through the patent literature. It became evident that the most promising results had so far been obtained from the hydrogen-oxygen cell, as opposed to other types such as the carbon-oxygen and carbon monoxide-oxygen cells.

A further reason for choosing the H-O cell in preference to others was the likelihood that it could first be developed for use on a small scale, as a kind of storage battery, using gases produced electrolytically from water. This might make possible the economic storage of electrical energy on a bigger scale than with conventional accumulators. It might also reduce the cost and increase the energy/weight and power/weight ratios to values suitable for some traction purposes.

If the production of electrical energy on a large scale using hydrogen produced direct from coal or chemical processes, and oxygen from the air, could be achieved, the chemical energy of oxidation of fuel could be converted into electrical energy without the intermediate production of heat. The theoretical efficiency of this process, although not as high as 100 per cent, is essentially much higher than is attainable in any known form of heat engine, the efficiency of which is governed by Carnot's theorem.

Principles of Operation of Cell

The working of the hydrogen-oxygen cell is simply a reversal of the process of electrolysis of water; in the cell, hydrogen is used as fuel, and is oxidised to water, electrical energy being generated in the process.

In all the familiar primary cells, such as the Daniell, Lèclanché, &c., metallic electrodes are used, which gradually dissolve in the electrolyte, the free energy of the oxidation process appearing mainly in the form of electrical energy. In the hydrogen cell, two "gas electrodes" are used, which take the form of metal electrodes, the surfaces of which are saturated with hydrogen and oxygen, respectively. It is well known that metallic nickel will adsorb quite large amounts of some gases such as hydrogen, the amount adsorbed depending on the total available surface of the metal. If such metal, or metal oxide, surfaces are kept supplied with hydrogen and oxygen respectively, they will behave as gas electrodes, the gas being consumed while the metal of the electrode remains unchanged.

The detailed operation of the hydrogen-oxygen cell may be explained as follows:—

Oxygen molecules are adsorbed on the metal oxide surface of the positive electrode; this adsorbed layer of gas is more active than molecular oxygen and is free to combine with the water present, forming two hydroxyl (OH^-) ions; hydroxyl ions have a single negative charge so that each ion as it is formed removes one electron from the oxygen electrode.

Each hydroxyl ion migrates into the electrolyte, in this case an aqueous solution of potassium hydroxide, and travels across to the negative electrode where it is discharged, combining with the hydrogen adsorbed on that electrode to form water, and depositing an electron in the process. The hydrogen electrode is negatively charged with respect to the oxygen electrode, and a current of electrons will flow in the external circuit from the hydrogen to the oxygen electrode.

The theoretical voltage of the cell is simply the free energy of the reaction per gramme-mol of water formed at the temperature and pressure used, divided by 2F, the charge carried across the cell in the formation of this amount of water, F being the Faraday, or 96,500 coulombs. The theoretical voltage falls with increasing temperature, and rises with increasing pressure.

Historical

The hydrogen-oxygen cell was first described by Sir William Grove in 1839, and particularly good results were recorded in 1889† by Ludwig Mond and Charles Langer, who achieved a current density of 6A per square foot (6·5mA per square centimetre) at 0·73V, using either oxygen or air; this corresponded to a useful efficiency based on the total heat of the reaction of nearly 50 per cent. Further progress was prevented largely because of the high capital cost of the platinum electrodes, this being the only metal then in use having the necessary active or highly developed surface for gas adsorption, required for the electrodes to behave as true gas electrodes. Since that time, large numbers of base metal catalysts have been developed for use in the chemical industry, their cost being only a small fraction of the cost of platinum. From the information available, it seemed likely that either nickel or cobalt would be the best metal for both electrodes, with the added possibility of silver for the oxygen electrode. It had previously been decided that an alkaline electrolyte, such as potassium hydroxide solution, should be chosen, since the use of sulphuric acid would be extremely difficult on account of the corrosion of any metal parts, especially at temperatures above atmospheric. The decision to try the above metals was reinforced by the low hydrogen and oxygen overvoltages shown by them, in alkaline solutions.

It also seemed probable, from information on the subject of catalysis, that if a metal such as nickel were tried for the electrodes, temperatures of about 200 deg. Cent. would be necessary for the best results to be obtained; with an aqueous electrolyte, this would also mean that pressures above atmospheric would be inevitable. Additional reasons for employing temperatures and pressures above atmospheric are that the speed of the chemical reaction should be greatly increased by both these factors, and also that the conductivity of the aqueous solution will be much higher at a higher temperature.

It became obvious that the problem would have to be approached essentially from the engineering point of view, rather than from that of a pure chemist. It was also decided that, before any applications could be contemplated, really high current densities of the order of at least 100A per square foot (108mA per square centimetre) would have to be attained, and this has been kept in mind throughout the investigation.

In recent years, some interesting work has been done on the hydrogen-oxygen cell at the Academy of Sciences, Moscow, by O. K. Davtyan; the results obtained were published in booklet form in 1947.

One cell developed by Davtyan worked at atmospheric temperature and pressure, with an alkaline aqueous electrolyte; the electrodes took the form of flat pockets of perforated nickel-plated steel, into which the active material was introduced; many kinds of active material were tried, but it was found that the best results were obtained with a hydrogen electrode of activated carbon impregnated with silver and an oxygen electrode of activated carbon impregnated with nickel. Rubber solution was used as binding material for the activated carbon, and the completed electrode was "waterproofed" or made water-repellent, with a very thin layer of paraffin wax. The purpose of this "waterproofing" treatment was to prevent the small pores in the interior of the electrodes from becoming flooded with electrolyte by capillary action. It will be appreciated that if a porous electrode is completely flooded with liquid, it is impossible for gas to be absorbed rapidly and the big internal surface is largely wasted. This water-proofing process is widely used nowadays in air-depolarised carbon electrodes employed in primary batteries, and is surprisingly effective. 35 per cent potassium hydroxide solution was used as electrolyte, and this, of course, was confined to the space between the electrodes. The best results obtained showed a current density of 25 to 35mA per square centimetre (23 to 33A per square foot) at 0·8 to 0·75V.

Another cell, based on previous work by Baur in Switzerland, was developed by Davtyan, for use with a solid electrolyte at temperatures between 550 deg. and 900 deg. Cent., and at atmospheric pressure. At these temperatures, certain kinds of glasses have a sufficiently high ionic conductivity to act as electrolytes. The hydrogen electrode was composed of ferric oxide plus iron, and the oxygen electrode of ferric oxide plus magnetic iron oxide. At a temperature of 700 deg. Cent., the cell gave a current density of 20mA per square centimetre at 0·8V. Either pure hydrogen or a mixture of hydrogen and carbon monoxide could be used; and air could be substituted for oxygen without serious loss of performance.

In spite of the promising results obtained with these two types of cell, it is believed that the current densities obtained were not really high enough for practical use; moreover, the cell working at atmospheric temperature would certainly be very sensitive to small impurities in the gases, and in the case of the high temperature one, the thin diaphragms of solid electrolyte were found to be very fragile, and liable to fracture during heating and cooling; a fractured diaphragm, at the high temperature used, would inevitably lead to an explosion.

The following basic decisions were made at the beginning of the present investigation, and they have been adhered to throughout:—

(*a*) Alkaline, rather than acid, aqueous electrolyte.

(*b*) Medium working temperature, about 200 deg. Cent., at which there should be no explosion danger.

(*c*) Medium working pressures, about 600 lb per square inch, at which standard power station practice, with regard to jointing, &c., can be used.

(*d*) No rare metals for electrodes, &c.; parts to be of nickel or nickel-plated steel, with the added possibility of silver or cobalt.

(*e*) Commercially pure gases to be used; no attempt to be made to employ impure industrial gases initially.

(*f*) No moving parts, such as electrolyte pumps, &c., which would introduce further problems.

(*g*) A minimum continuous current density of 100A per square foot (about 107mA per square centimetre) at 0·8V.

Types of Cell Investigated

1. In 1938, a small glass apparatus was constructed, working at atmospheric pressure, on the lines of the original Grove gas battery.‡ Platinised platinum gauze electrodes were used, the electrolyte being sulphuric acid. The output

* Based on Report Ref. Z/T94, published by The British Electrical and Allied Industries Research Association.

† *Proc. Roy. Soc.*, 1889, A.46, 296.

‡ *Phil. Mag.*, 1839, III, 14, 388.

increased up to the boiling point of the liquid, but when nickel, activated by alternate oxidation, and reduction at 700–750 deg. Cent. was tried in an electrolyte of caustic potash, poor results were obtained.

2. In 1939, a cell was designed which would stand a pressure of 3000 lb per square inch and any reasonable temperature. The electrolyte was 27 per cent caustic potash, and the cell was lined throughout with pure nickel. Activated nickel gauzes were again used as electrodes, which were cylindrical, and which were separated by a diaphragm of asbestos cloth. Other metals, such as platinum, palladium, silver and copper were tried, but were discarded in favour of nickel, because the latter gave the best performance. The cell was tested by alternately charging it from an external source of direct current, and discharging it through an ammeter and variable resistances at a constant current. It was found

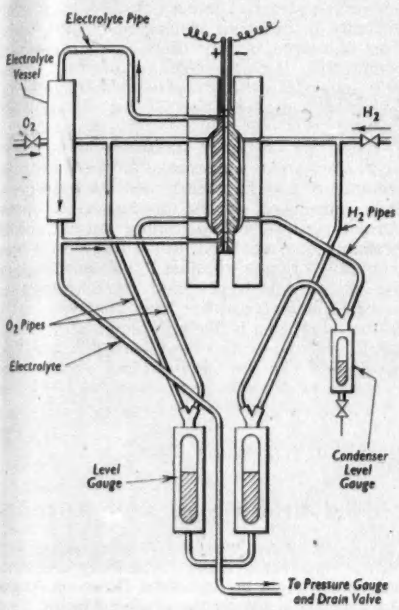


Fig. 1—Diagram of apparatus for experimental work on the hydrogen-oxygen cell

finally that a current density of 12·2A per square foot (13·1mA per square centimetre) of the external surface of the inner electrode could be maintained for about 48 minutes at about 0·89V, with a temperature of 100 deg. Cent.; many thicknesses of gauze were used in each electrode to get these results, and fairly high pressures were used. Curiously enough, no advantage was obtained by using higher temperatures than 100 deg. Cent., and this was tentatively ascribed to the irreversible anodic oxidation of the oxygen electrode during the charging period. The overall energy efficiency of the double process of charge and discharge was 47·1 per cent.

3. In 1940, the late Dr. C. H. Merz, then the senior partner of Messrs. Merz and McLellan, consulting engineers, made arrangements for the work to be continued at King's College, London, under the supervision of the late Professor A. J. Allmand. It was decided that two cells should be constructed, with interconnecting pipes, one being used as an electrolyser for generating the two gases, and the other as the current-producing cell. The gases produced in the electrolyser were carried up into the cell in solution in the electrolyte, the liquid subsequently returning to the electrolyser through separate pipes. Each electrode had a separate electrolyte supply, so that the two gases could not become mixed. Activated nickel gauze electrodes were again used, and asbestos diaphragms, both electrodes and diaphragms being in the form of flat discs. The work with this cell arrangement had to be discontinued in 1941 owing to war-time difficulties, but was restarted at Cambridge in 1946, the work being financed by the Electrical Research Association. The research was commenced in the Department of Colloid Science under the supervision of Professor Sir Eric Rideal, F.R.S. The principal conclusions made in 1948 from the results obtained with this apparatus were as follows :—

(*a*) The performance of the cell improved with increasing temperature up to 240 deg. Cent., the maximum temperature tried.

(*b*) High pressures also appeared to be favourable up to 1075 lb per square inch (73 atmospheres), the highest tried.

(*c*) The highest current density obtained was 75A per square foot (81mA per square centimetre) at 0·65V ; this was with six gauze electrodes on each side of the cell, at 240 deg. Cent.

(*d*) The highest open-circuit voltage recorded was 1·086V at 200 deg. Cent. and 1000 lb per square inch (68 atmospheres). The theoretical voltage under these conditions is 1·210.

(*e*) Six gauze electrodes on each side of the cell gave about six times the output obtained with single gauzes.

(*f*) An oxygen electrode of porous sintered nickel was tried, but did not give outstandingly good results ; it was used in the same way as the gauze electrodes and was completely flooded with liquid.

(*g*) The materials of construction used, namely, pure nickel, nickel-plated steel, pure asbestos cloth, and standard steam pipe jointing, proved to be entirely satisfactory, and the nickel gauze electrodes showed no signs of deterioration with time, a thin durable black oxide layer being built up on the oxygen electrode.

(*h*) The current density obtained appeared to be limited by the rate at which fresh gas could be brought up to each electrode, in solution in the electrolyte.

4. As the current density obtained was still below what was considered to be the minimum for any practical application, namely, 100A per square foot of the cross-sectional area of the cell, it was decided that a new apparatus should be built, using porous nickel electrodes, with the gases confined to the backs of the electrodes. The rate at which the reaction on the electrodes takes place at a given voltage depends on the concentration of dissolved gas close to the active surface. Where the rate of reaction is determined by the rate at which this gas can be replaced by diffusion through the liquid, the diffusion layer must be reduced to a minimum. In the " diffusion gas electrode " the diffusion layer is extremely thin, and much higher current densities are to be expected for a given effective surface area of the electrode. The new apparatus, using compressed gas from cylinders instead of from an electrolyser, was completed early in 1949 in the Department of Metallurgy (Professor G. Wesley Austin, O.B.E.), and has been used with little change ever since. Since 1951 the work has been continued in the Department of Chemical Engineering (Professor T. R. C. Fox.)

The main essentials of the apparatus in its present form are shown in Fig. 1, which is largely self-explanatory. A photograph of the cell itself is reproduced in Fig. 2.

The general design of this apparatus was decided on in collaboration with Mr. T. M. Fry (now at the Atomic Energy Research Establishment at Harwell), who has given advice on the physical aspects of the work since 1946, while the Research and Development Department of the Mond Nickel Company, Ltd., at Birmingham, made the porous nickel electrodes.

The porous nickel electrodes, which are about 4mm thick, are made with a pore size of about 30 microns on the gas side, and with a thin layer of a much smaller pore size on the liquid size ; a small pressure difference is set up in the apparatus across each electrode, so that the liquid is expelled from the large pores on the gas side, but cannot bubble through the smaller pores on the liquid side ; thus it is unnecessary to use a diaphragm between the electrodes, a great practical advantage ; and the interior of the 30 micron pores presents a very large surface for absorption of gas.

The main cell parts are of steel, nickel-plated by the " Fescol " process, and the pipework is of nickel. The two halves of the cell are bolted together with insulated bolts, and the joints are made with standard steam pipe jointing supplied by Richard Klinger, Ltd.; this also acts as an electrical insulator between the two electrodes. The cell is circular in shape and is 5in in internal diameter. Two Klinger boiler water level gauges are incorporated in the apparatus at a convenient distance below the cell, so that the required pressure difference is set up across both electrodes ; two gas connections (rather than one) are made to each level gauge, to ensure proper drainage of liquid from the small-diameter pipes. All the pipework runs almost cold, with the exception of the electrolyte circulation. A small electrolyte vessel is incorporated, to reduce the change in concentration of the 27 per cent KOH with time, when running on load.

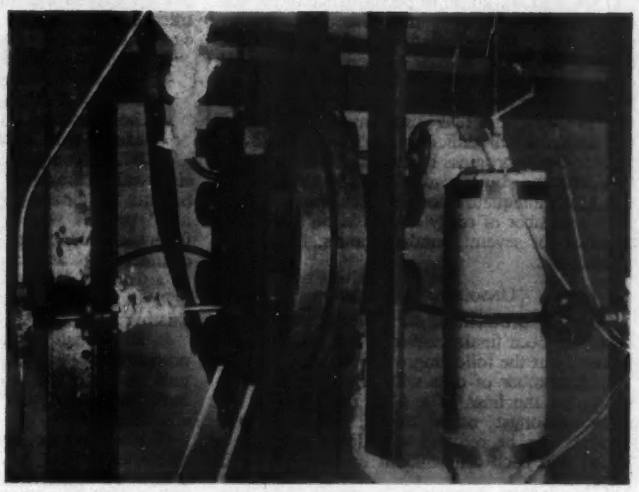


Fig. 2—Apparatus for experimental work on hydrogen-oxygen cell

When running for long periods on load it has been necessary to incorporate a device for removing the water formed ; the hydrogen is encouraged to circulate by thermosiphonic action past the back of the hydrogen electrode where it picks up water vapour which evaporates rapidly from the porous surface ; the mixture of hydrogen and water vapour is cooled externally, and the condensate is collected in a trap (Fig. 1) and released to atmosphere from time to time. When running a single cell at a current of 30A about 10 ml of water are formed per hour, so the actual amount of condensate to be dealt with is quite small.

Electric heaters are clamped on to the outside walls of the cell, the temperature of which is kept constant by an electronic device operated by a " Thermistor."

The cell is discharged through variable resistances and the output measured by a voltmeter and ammeter.

Briefly, the conclusions from the use of this apparatus are as follows :—

(*a*) As before, the performance of the cell improves with both temperature and pressure.

Variation of Cell Voltage with Load (Current Density)

Current density...	A/ft²	0	151	384	670	1000
	mA/cm²	0	162	413	720	1076
Voltage	Volts	1·05	0·9	0·8	0·07	0·6

(*b*) The best performance obtained so far has been at 240 deg. Cent. and 800 lb. per square inch (54·5 atmospheres) total pressure, the output being as shown in the table above :—

(*c*) The highest open-circuit voltage has been 1·096 at 200 deg. Cent. and 571 lb per square inch (38·8 atmospheres) total pressure. The theoretical voltage under these conditions is about 1·19.

(*d*) The current efficiency, assuming that no oxidation of electrodes, &c., is taking place, should approach 100 per cent at any useful discharge current density, but it has not been possible yet to check this in practice. If this proves to be true, then the energy efficiency of the cell, based on the free energy of the reaction, will approximate, above this small current density, to the voltage efficiency ; e.g. at 0·9V and 240 deg. Cent. and 800 lb per square inch, the energy efficiency will be $(0·9/1·17)\times 100 = 77$ per cent, and at 0·8V it will be 68 per cent.

(*e*) It is believed that, when running on load at, say, 200 deg. Cent., which is probably the most suitable operating temperature, the losses, appearing in the form of heat, are mainly due to the irreversibility of the electrode reactions, or what may be called activation polarisation ; a smaller proportion of the losses are due to resistance and concentration polarisation. On open circuit and at low current densities there will in addition be a " lost current " due to diffusion of the two gases in solution through the electrolyte, followed by combination on the opposite electrode.

(*f*) A gradual fall-off in performance of the cell occurred with time ; this was undoubtedly associated with the gradual oxidation of the oxygen electrode, and has been the principal obstacle to further progress. The work in recent years has been concerned almost entirely with this problem, and it is confidently believed that this fundamental difficulty can finally be overcome. Great progress has already been made in this direction, but it would be unwise to claim that really adequate durability has been obtained until a number of really long tests on load, over a period of several hundred hours, have been carried out.

Unsolved Problems

Once the problem of durability of all the cell parts has been finally solved it will be necessary to carry out the following work :—

1. A number of cells will have to be built in series, on the lines of a filter press ; this will show, amongst other things, whether stray currents can be reduced to a low value. It is hoped that each cell will not be more than ½in thick.

2. Automatic gas admission valves must be developed, so that the right amounts of each gas are introduced under all conditions of load, and the total pressure in the apparatus is kept constant.

3. Automatic gear will have to be developed for removal of the water formed by the method, mentioned above, of evaporation of moisture from the gas side of the hydrogen electrode ; this method has already shown considerable promise.

4. When larger units are built, which will maintain the working temperature by internal energy losses without external heating, it will be necessary to develop an automatic device for keeping the temperature constant under all conditions of load. A method of heating up from cold will also have to be worked out, for units isolated from the mains.

5. The manufacture of electrodes is not an easy process, and it may be that when much larger electrodes are made special difficulties will be encountered which will need further development work.

Proposed Applications

It should first be explained that it is not proposed at present to use the cell reversibly ; that is to say, it is not proposed to use it for generating the gases electrochemically from water, as well as consuming them. For generating the gases, standard electrolysers would be made use of at present. It should also be understood that this method of storing energy is unlikely ever to compete with existing accumulators of small size to any extent, as it is believed that it could not be used economically in very small sizes, owing to excessive heat losses. Further, the energy-to-weight ratios will become progressively better as the length of time of discharge at full load is increased ; if a large capacity is required, for a given power, the main part of the weight will be in the gas storage cylinders ; it can be shown that the total weight of the storage cylinders would be 15–20 lb per kWh of available energy, the discharge voltage being taken as 0·8V.

Moreover, it is hardly conceivable that it could ever compete on a weight basis in its present form with a petrol engine, on account of the great weight of the gas storage cylinders, and the fact that oxygen must be carried also, instead of being drawn from the surrounding atmosphere. It should be mentioned that, when comparing the energy efficiency with that of a heat engine, the total heat of the reaction should be taken as a basis in both cases rather than the free energy ; on this basis the maximum possible efficiency of the hydrogen-oxygen cell is about 67·5 per cent at 1·0V, 61 per cent at 0·9V, and 54 per cent at 0·8V.

The probable advantages of the H-O cell in practice can be summarised as follows :—

1. Efficiency of utilisation of fuel, compared with any kind of heat engine. The efficiency quoted above does not take into account the surplus heat at, say, 200 deg. Cent. available from internal losses, over and above that required for maintaining the working temperature. This might be put to good use in certain applications.

2. Ability to take large overloads at reduced efficiency, thus making it inherently suitable for traction purposes. The low-voltage direct current produced is also very suitable for traction.

3. Complete silence and lack of vibration.

4. Virtually no moving parts.

5. The fact that the " exhaust " is only water.

6. The fuel would be home-produced, i.e. would be produced from coal.

7. When compared with existing types of electrical accumulator, it is believed that it would be both lighter and more compact ; the " charging " process would merely consist in feeding fresh gas into the storage cylinders from stationary cylinders kept at a rather higher pressure. Taken as a whole it is believed that it would extend the field of electrical storage rather than displace existing methods.

It is difficult to be very definite about the precise fields of application of hydrogen batteries until a prototype of perhaps 2·5kW has been built and tested, but the following suggestions can be made :—

(i) Rail traction, on lines which have not been electrified. The gas would be generated in stationary electrolyser plants, which would either be operated throughout the twenty-four hours or else only during the night ; it would be stored at high pressure and transferred to the locomotive by means of high-pressure hoses. It is hoped that eventually high-pressure electrolysers, possibly also operating at temperatures above 100 deg. Cent., will become available ; this would improve the overall efficiency of the whole process very much.

(ii) Road traction, in certain cases where its special characteristics might make it peculiarly suitable.

(iii) Storage of wind power ; in this case a large capacity would be required, to allow for windless periods of several days' duration, so this method of electrical storage might compare very favourably with alternative methods.

(iv) It has often been suggested that a cell of this type could be used as a genuine fuel cell for generating power on a large scale, using hydrogen produced from coal by ordinary chemical methods, and oxygen from the air. This is, of course, a much more ambitious project and cannot honestly be envisaged at present owing to the high cost of pure hydrogen produced in this way, compared with the cost of raw coal, the normal fuel for power stations. However, it is conceivable that impure industrial gases composed of a mixture of hydrogen and carbon monoxide could be used in a cell of this kind, with certain essential modifications ; this has not yet been tried. There is not likely to be great difficulty in using air instead of oxygen, apart from the large amount of power consumed in compressing it to the working pressure of the cell; only part of this power would be recoverable on subsequent expansion of the nitrogen left over.

The siting of power stations would become easier, owing to the absence of any need for large amounts of cooling water ; and the fresh problems introduced by the production of direct current, instead of alternating current, could probably be overcome. But it has always been emphasised that a so-called " fuel cell " making use of pure hydrogen and oxygen possesses immense advantages over any other type, owing to the fact that it is likely to be useful first on a small scale ; in this way valuable practical experience can be obtained before the vast problems associated with the production of power on a large scale need be contemplated.

First British Supersonic Aircraft

The first aircraft in this country designed to sustain supersonic flight, successfully completed its maiden flight at Boscombe Down on August 4th. It was made by the English Electric Company, of Warton, near Preston, and is fitted for its immediate tests with two Armstrong Siddeley " Sapphire " turbo-jet engines housed in the fuselage. In accordance with present security procedure, no details of the machine can yet be disclosed. It can be seen from the illustration, however, to have retained a more conventional configuration than that characteristic of the family of American machines in the supersonic category. In order to accelerate the development of supersonic aircraft in this country some twenty of these machines have been ordered.

English Electric " P-1 " aircraft. It is an interceptor fighter powered by two Armstrong-Siddeley " Sapphire " turbo jets and is capable of supersonic speed in level flight

Koepe Winder for the National Coal Board

We learn that a 3720 h.p. Koepe winder has been installed for the National Coal Board at No. 2 shaft, Bradford colliery, Manchester. It is the first Koepe winder to be installed in Great Britain since 1927 and is the biggest so far completed for a British coal mine. The equipment was supplied and installed by Metropolitan-Vickers Electrical Company, Ltd., as main contractors, the mechanical portions being manufactured by Fraser and Chalmers Engineering Works, and the gears by David Brown and Sons, Ltd.

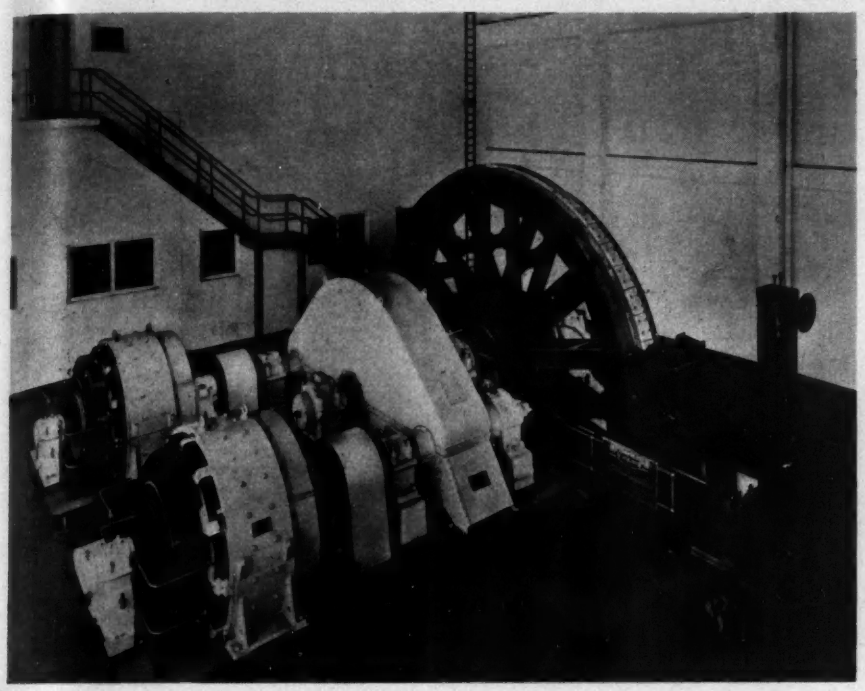
The new winder is designed for winding from an ultimate depth of 3822ft, which will be reached in three stages, each stage having a life of about thirty years. Two skips, each of 12 tons capacity, and for the first stage a locked-coil rope, will be used. The main technical particulars are tabulated below.

Main Particulars of Ground Type Koepe Ward-Leonard Geared Winder at Bradford Colliery

Vertical shaft :	
Depth, Stage 1	2802ft
Depth, Stage 2	3312ft
Depth, Stage 3	3822ft
Headgear : sheaves in line (fleet angle none)	
Skips :	
Number of skips per winder	Two
Weight of skip and chains	14·5 tons
Load :	
Net load of coal per skip	12 tons
Output per hour, all stages	400 tons
Main rope, Stage 1 : Locked coil, equal lay, rust-resisting	
Diameter	2¼in
Weight per fathom	74·8 lb
Guaranteed breaking load	278 tons±5 per cent
Maximum rope speed	37·8ft per sec
Balance rope : multi-flattened strand, non-rotating, rust-resisting :	
Circumference	8¼in
Weight per fathom	72 lb
Estimated breaking load	180 tons
Koepe wheel :	
Diameter	24ft
Maximum speed, Stage 1	30 r.p.m.
Maximum speed, Stage 2	35·5 r.p.m.
Maximum speed, Stage 3	41 r.p.m.
Gears, single reduction	8·68 : 1
Winder motors, two, full speed :	
Stage 1	260 r.p.m.
Stage 2	308 r.p.m.
Stage 3	357 r.p.m.

The ultimate stages of the winder will not come into operation for a number of years, and the size of rope to be used for these greater depths has not yet been decided upon. The winder was designed on the basis of a 2⅞in multi-strand rope of approximately 84 lb to the fathom, but a locked coil alternative may eventually be used.

The photograph we reproduce was taken just before the rope was fitted. The motors are coupled to the pinions by Bibby flexible couplings. The main spur gear wheel is on the same shaft as the Koepe wheel, and the whole is mounted on three pedestal bearings. The wheel tread material is elmwood, which, when used in conjunction with a locked coil rope, appears to have extremely good resistance against wear ; this is borne out by experience of such a combination at the Emma Colliery of the Dutch State Mines. The brakes are of the anchored-post type, controlled by a Metropolitan-Vickers spring brake mechanism. The brake engine and control gear are installed in the basement below the winding engine. The driver's control cabin is situated on a platform in line with the Koepe wheel and contains a driver's desk and trip indicating panel. On the winder house floor are mounted the Ward-Leonard control panel, the A.T.M. signal relay cabinet, and the Metropolitan-Vickers mine hoist recorder.



Koepe winder being installed at Bradford colliery. This photograph was taken before the rope groove had been cut in the Koepe wheel

To assist in rope installation and changing, a 300 h.p. winch is provided, having a single plain cylindrical drum driven by a slipring induction motor. This winch is in the headgear structure and is controlled from an adjacent driver's platform. The switchgear and liquid controller for the winch are outside the air lock in a room next to the winding engine room, the entrance to which can be seen in the photograph.

Power supply for the winder motors is taken from a motor-generator set situated in the power-house, which is a separate building containing three turbo-compressor sets, the motor-generator sets for Nos. 1 and 2 winders, and the colliery substation ; the whole of this equipment was supplied by Metropolitan-Vickers Electrical Company, Ltd. The motor-generator set for the winder under consideration consists of a 3070 h.p., 750 r.p.m., 6·6kV synchronous-induction motor directly coupled to two generators, which are electrically interleaved with the winder motors, the d.c. voltage of the system being 660V on r.m.s. loading. The synchronous induction motor has "VAX" control of power factor and is excited by a 26·4kW, 43·5V, overhung generator. The Ward-Leonard exciter is a 23·3kW, 220V machine and is overhung at the opposite end of the motor-generator set.

The winder motors have the following rating : 3720 h.p., continuous r.m.s.; 6000 h.p., normal working peak ; 8600 h.p., peak torque for rope-changing duty.

The electrical control scheme is on the standard open loop system. In all, twelve 1 square inch section cables are installed between the motor generator house and the winders, i.e. three cables per leg of the connection.

Stalling Protection for Induction Motors

A stalling relay has been developed by the P. and B. Engineering Company, Ltd., Crawley, Sussex, for the protection of induction motors when stalled, a contingency that may arise with certain drives, such as pulverised fuel mills and crushers. In devising this system of protection the aim was to produce a relay which would operate in a very short interval after stalling (without operating on a healthy start) which would not reset too fast and would permit restarting, but would prevent repeated attempts to restart if the motor remained stalled.

In its simplest form the relay consists of a contactor and a thermal overload unit. The contactor closes only when the motor is starting or if the motor stalls whilst running. As long as the contactor is open the thermal unit is short circuited, and therefore cannot operate, but when the contactor closes it switches the thermal unit into circuit and, after an interval, the thermal unit operates, disconnecting the motor. If, however, the motor current falls to normal before the thermal unit operates, which happens during a "healthy" motor start, the contactor falls out and cuts out the thermal unit again. After operation the thermal unit resets slowly, giving hot spots in the motor a chance to even out before restarting is possible. The sequence of operation is shown diagrammatically in Fig. 1.

If required, the equipment can be supplied with an auxiliary "twice-in" relay, which allows one restart of the motor to be attempted after a stall, but if the stall persists latches in, thus preventing further attempts to restart. The "twice-in" relay consists of a shunt-connected attracted-armature relay with a follower pin attached to the top of the armature, moving in a labyrinth slot in a hinged metal plate (Fig. 2). As the armature moves in and out on successive stalls the follower pin works through the labyrinth slot, allowing the hinged plate to fall until, on the second stall, the follower pin is trapped in the end of the slot and so latches the armature. A flag is attached to the labyrinth plate and the sequence of operations is as follows. Unless a stall has taken place the flag shows a green field. If the motor stalls the armature closes, clearing the fault, then half opens, resetting one pair of contacts and so allowing a restart. At this position the flag shows a red-green field (one pair of contacts can be adjusted to remain closed to connect a warning light to show that a stall

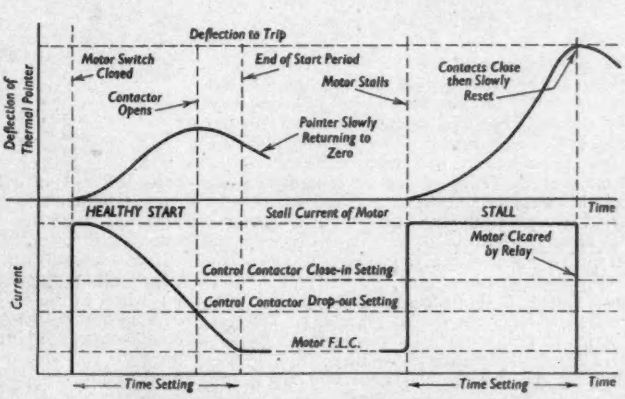


Fig. 1—Operating sequence diagram of stalling relay

has taken place). If a second stall occurs the armature closes and latches in and the flag shows a red field. A second warning light can be arranged to show when two stalls have taken place. Before the motor can be restarted the relay must be hand reset, and a special reset knob

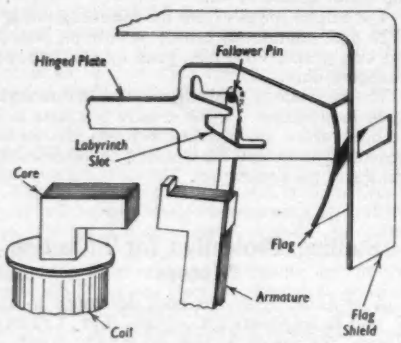


Fig. 2—Diagrammatic sketch of auxiliary relay latch-in system.

is provided to take a padlock, so that the operator must call someone in authority to reset the relay, to ensure that the motor is not restarted too soon.

If, however, the motor restarts without a second stall the flag continues to show the red-green field until reset at some convenient future time by the operator. This operation can be done with the motor running, as resetting does not close the trip contacts; but, as the reset knob is padlocked, resetting ensures that someone in authority will be made aware that a stall has occurred.

The thermal unit, which consists of an assembly of bimetallic coils, is compensated for changes in ambient temperature. It has an inverse time/current characteristic so that during the greater part of the starting period, when the current is well below the stall current, the unit operates more slowly than it would do on a stall. Consequently the time to trip on a stall can be very close to the starting time, and in many cases equal to it. Discrimination is further assisted by the fact that the bimetallic elements in the unit are directly heated by the current, not by a separate heater, giving a movement entirely free from overrun. Time settings are obtainable from 5 to 180 seconds, and the relay (Fig. 3) can be supplied for operation with current transformers or for direct connection up to 60A and is available in flush or projecting pattern cases.

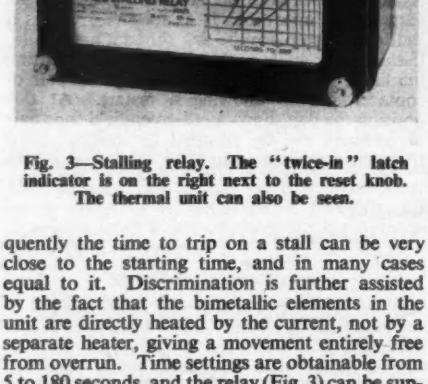


Fig. 3—Stalling relay. The "twice-in" latch indicator is on the right next to the reset knob. The thermal unit can also be seen.

It should be appreciated that the stalling relay is designed to supplement the P. and B-Golds relay, and cannot be used in place of it. Whereas the thermal elements in the P. and B-Golds relay give protection against overload and single phasing, the stalling relay does not operate on either of these faults, but only when a motor stalls during either starting or running.

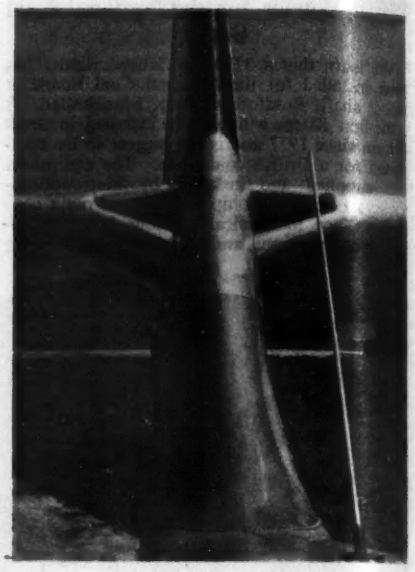
Development of "Seamew" Anti-Submarine Aircraft

SINCE its first public appearance in the S.B.A.C. display at Farnborough in 1953, the Short "Seamew" anti-submarine aircraft has been undergoing an intensive flight testing programme. Only seventeen months elapsed between the design conception and the first flight of the aircraft in August, 1953, and in undertaking its development the company aimed to produce an aircraft at low cost which can perform with complete efficiency all the duties formerly designated to more elaborate and expensive anti-submarine machines.

The "Seamew" is capable of operating from all types of carriers—including converted merchant ships—and from hastily contrived airstrips almost irrespective of weather conditions. The aircraft is very manœuvrable and has a low landing speed.

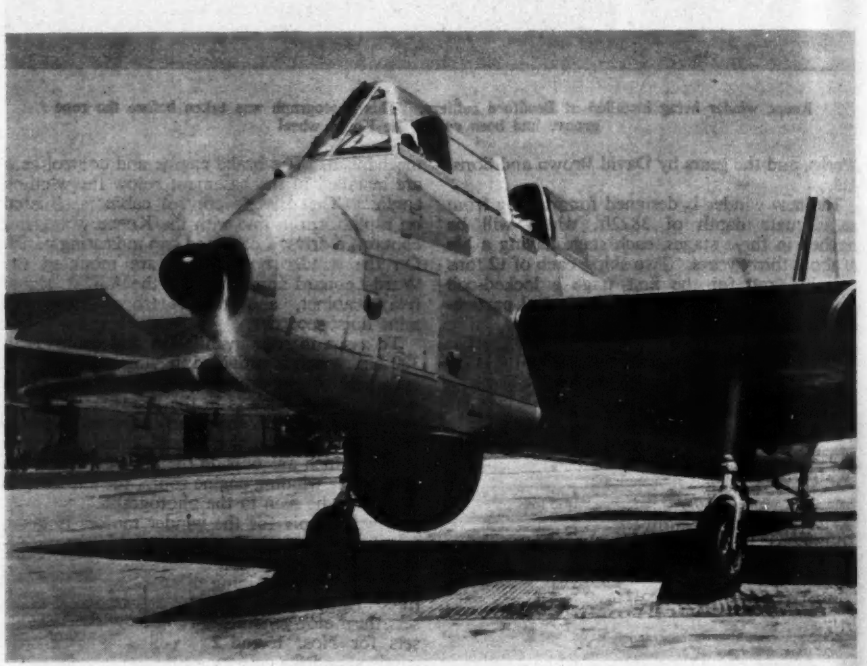
Its development has involved the introduction of new forms of construction, which have called for a comprehensive testing programme. A degree of aerodynamic control seldom encountered before has had to be provided and trimming the overall dimensions to suit the parking lift of an aircraft carrier raised substantial difficulties, especially with regard to the elevator and rudder control at the critical landing speed. This control was finally achieved by introducing a vented fillet in the tailplane, which overcomes buffeting by accelerating the airflow near the vent, and a horn-balanced rudder; to obtain the best stalling characteristics a small slat has been introduced on the leading edge of the wing. To give the quick response necessary on approach for the deck landing of an aircraft with a propeller turbine, a special form of tail undercarriage with a double extension has been provided. The upper portion of the undercarriage leg is a normal oleo, while the lower portion contains a dashpot, which, when released, allows the tail wheel leg to extend fully. Thus, on touch-down, the undercarriage remains fully extended and so maintains an attitude similar to that of a tricycle undercarriage. The dashpot, however, is arranged to compress slowly, at a rate which permits it to be fully compressed at the conclusion of a normal deck landing. A catch then engages automatically to retain the tail wheel in the right position for take-off.

A second complete aircraft, less engines and equipment, was built for overall major structural testing. This aircraft has undergone a complete test programme in Belfast, consisting of four major test cases. On the fourth case, namely that representing the aircraft pulling out of a dive up to maximum fully factored "g's," the loading was carried to ultimate failure, which precisely met the required design conditions.



A close-up of the "Seamew" tail showing the vented fillet in the tailplane leading edge

An aspect of the structural testing, which is believed to be unique in this country, is that under all the test cases the aircraft was "floating," the complete loads simulating the appropriate flight case being applied to wings, tailplane, fin, engine mounting and fuselage (and, where appropriate, to undercarriages), simultaneously. By the intensive testing programme which has been carried out Short's aim at obviating the need for any further modifications—which so frequently occur—after the aircraft is in service. The initial stages in quantity production of the aircraft are already under way.



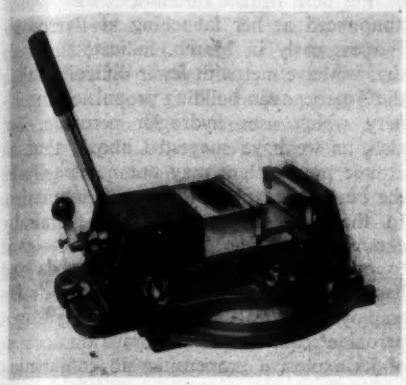
The "Seamew" anti-submarine aircraft. The "radome" and one of the small leading edge slats can be seen

INTERNATIONAL SCIENTIFIC FILM CONGRESS.—The 8th Annual Congress and Festival of Scientific Films of the International Scientific Film Association will take place in Rome from November 6 to 12, 1954. Enquiries from this country should be sent to the Scientific Film Association, 164, Shaftesbury Avenue, London, W.C.2, while overseas enquiries should be sent to the congress secretariat: Segreteria VIII Congresso Internazionale della Cinematografia Scientifica, Commissione per la Cinematografia Scientifica del Consiglio Nazionale delle Ricerche, Piazzale delle Science, 7, Roma.

Hydraulic Machine Vice

PARTICULARS have been received from B. Elliott and Co., Ltd., of Victoria Works, London, N.W.10, of a hydraulically operated machine vice which this firm is now making. This vice is made in two models with maximum jaw openings of 3½in and 6in, each model having a jaw width of 5in, jaw depth of 1 ⅛in, and capable of exerting a holding pressure of up to 14,000 lb on work-pieces.

The hydraulic system consists of a hand-operated pump housed in a reservoir in the vice



Hydraulic machine vice capable of exerting a holding pressure of up to 14,000 lb on work pieces

body and which delivers pressure oil to a cylinder which has its ram coupled to the moving jaw. As can be seen from the photograph we reproduce, the pump handle can be used on either side of the vice. A quick-action release valve with its control knob in a convenient position at the rear of the vice releases the oil from the cylinder back to the reservoir. The moving jaw is spring loaded to the open position and the spring pressure is sufficiently strong to return the jaw when the release valve is opened. The amount the jaw is opened to free a workpiece is controlled by the time the release valve is held open—which can be a minimum on repetition working so that a short stroke of the pump handle is sufficient to grip the next piece for machining.

The reservoir is provided with two air vent holes and a gravity controlled valve mechanism which prevents oil leakage should the vice be tilted. If the vice is turned completely over both valves shut ; if it is tilted to the right or left either one of the valves remains open, whilst the other is closed. The release valve arm is fitted with a spring loaded thumb screw which, when turned in the fully forward position, prevents accidental use during machining.

Dock Gate for the Port of London Authority

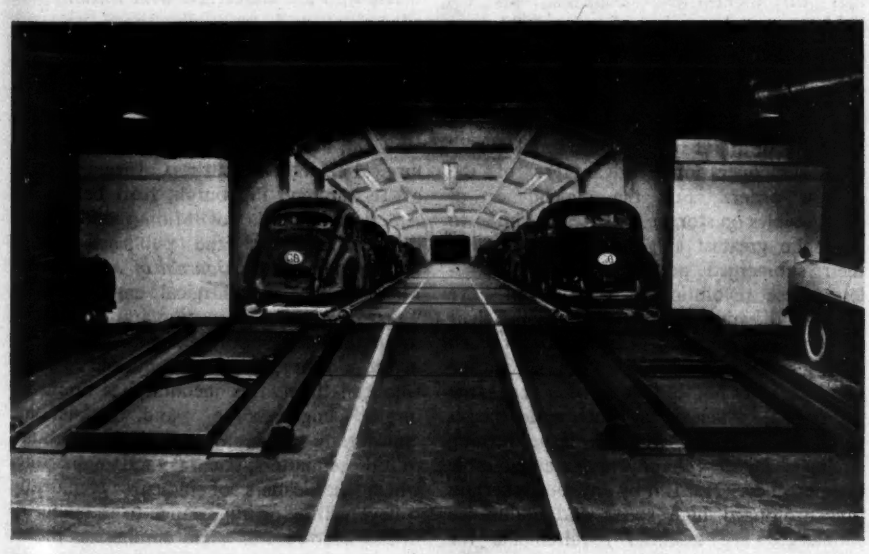
DETAILS of a new dock gate, built for the Port of London Authority for installation at the Royal Victoria Docks, have been received from the makers, Vickers-Armstrongs, Ltd. The gate is formed of two leaves which, when stepped, are to form the outer gate of the western entrance of the Royal Victoria Docks. The structure of each leaf is of "pickled" mild steel plates and every connection is fully welded ; the sizes of the welds are in accordance with Lloyd's rules for electric arc welding of ships. The overall dimensions of each leaf are width 48ft 3in and mean height 26ft ; the depths at the heel post, mitre post and the midpoint of the width, are 24in, 27in, and 8ft 3in, respectively.

Each leaf comprises a curved watertight skin, a flat watertight skin, nine horizontal ribs and three vertical diaphragms. One lower rib and the centre diaphragm are watertight, thus forming four watertight compartments, of which the lower two are buoyancy chambers and the upper two, tidal chambers. The latter are always open to the river, having scuppers in the curved skin at the level of the lower surface of the chamber. All surfaces of each leaf, inside and outside, are coated with bituminous enamel, except the lower surfaces of the buoyancy chambers, which are covered with 1in of bituminous concrete.

The flat skin is protected by elm fenders and a steel-framed gangway is bolted to the top of each leaf. The timber used on the watertight boundaries is greenheart. At the heel, the timber is dressed to 12½in radius, and at the mitre the bearing surface is 27in. The greenheart clapping sill is scarffed into the heel and mitre posts, forming a greenheart bearing surface around three sides. The greenheart is bedded in a mixture of red and white lead and is secured to the steelwork with "sheradised" nuts and bolts. The weight of each leaf is taken by the heel socket and a roller, secured to the gate, which runs on a granite pathway at a radius of 34ft 3in from the centre of the heel post. The pressure on the roller can be adjusted by a spear post, which also helps to hold the roller in position.

Mechanical Car Parking

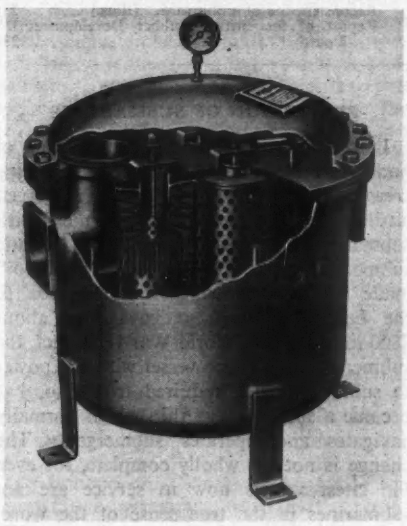
OUR illustration shows the hydraulically operated platforms used in a parking system demonstrated recently in a London garage by the Cap Mechanical Car Parking Systems, Ltd., 6, Bedford Row, London, W.C.2. The parking space is divided into a number of bays, each served by a central driveway. On each side are hydraulically operated wheeled platforms, which can be independently operated. When parking a car a platform is moved sideways into the driveway, the car is driven on and the platform, carrying the car, is retracted. The operation is quick and the system has the advantage that cars can be parked bumper to bumper without inadvertent damage by manœuvre and that the access way is narrower than that which could be tolerated with any other system. The company maintains that for 90 deg. parking one car alongside the next one, the approximate space taken up by an average car is 232 square feet with 184 cars to the acre ; by parking the cars at an angle of 45 deg. a car takes up 300 square feet, and only 145 to an acre can be parked, whereas by using the mechanical system an equivalent car only takes up 173 square feet and 260 cars to an acre can be parked, an increase of over 40 per cent.



Mechanical Car Parking : Two demonstration platforms and an artist's impression of a fully equipped garage

Petroleum Filter

THERE has been designed and developed by The Automotive Products Company, Ltd., Leamington Spa, for the efficient full-flow filtration of light hydrocarbons, a new "Purolator" large capacity filter for the petroleum and aviation industries. The filter, shown in our illustration, consists of a steel outer casing of welded construction, treated to resist rust and corrosive action and designed to operate at a normal pressure of 100 lb. per square inch. Within the casing are eight "Micronic" filter elements, which are made of plastic impregnated paper



Sectional view of "Purolator" filter

and are waterproof, heat resistant and capable of removing contaminants, of sizes measured in microns, at relatively high rates of flow.

The element is designed so as to provide a specially large filtering surface in proportion to its volume, the paper being pleated around a central metal former. When a pressure difference of 15 lb per square inch is recorded on the gauges at the inlet and outlet of the casing the elements are ready for replacement. The filter body is provided with 3in flanged connections, and these remain unbroken while the unit is being serviced. The filter, which is suitable for aircraft refuelling tankers and trolleys, airfield pipeline installations and engine test bed installations, has a height of 21·5in, an overall width of 22·5in, with a distance of 21in between inlet and outlet flanges, and a capacity of 200 gallons per minute.

AIR OPERATED GUILLOTINES.—F. J. Edwards, Ltd., of 359–361, Euston Road, London, N.W.1, is now making two models of compressed air operated guillotines 36in wide and 49in wide, respectively, for shearing mild steel sheet up to 16 S.W.G. These machines have a foot-operated remote valve controlling two "Marton" air cylinders connected by links to the top shearing beam. After each working stroke the beam is returned to the top position by air pressure and the machines can be arranged for single stroking or repeat action. Adjustable front, back and side stops gauge up to 20in from the back stop and 24in from the front. An automatic hold down also acts as a guard to the shear blades.

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PROPULSION OF SUBMARINES

It is now part of the normal training of both British and United States submarine crews to carry out voyages submerged lasting several weeks. A year ago the British submarine "Andrew" crossed the Atlantic submerged and recently the "Tallyho" made a similar crossing from Bermuda to the English Channel, a voyage of about 2800 miles. Since World War II, in fact, the submersible, a surface vessel with the power to submerge when required to do so, has become a submarine, a ship which normally navigates and operates submerged. The change is not yet wholly complete, for even the latest vessels now in service are not submarines in the true sense of the word. As their diesel engines require air, they must, if they are to remain submerged, use the "Snort" for charging their batteries and for making a passage at slow speed. Otherwise they are dependent on storage batteries, which are adequate for patrolling at speeds of from 1 to 2 knots and, when high speed is necessary, will last for one hour at 17 or 18 knots. The "Snort," moreover, is no longer immune from detection by radar under reasonably good weather conditions. It also necessitates the vessel remaining at periscope depth and thus liable to ramming by surface vessels in the vicinity.

The Germans, in efforts to obtain increased speed and endurance for their U-boats during the war, regarded the "Snort" as a temporary expedient while they hastened to complete their types "XVII" and "XXVI," both of which were fitted with a revolutionary power plant using hydrogen peroxide as oxydant for fuel. When the war ended a few of the former—with only one turbine engine—were on the point of completion. The larger type "XXVI," with two engines and with an estimated submerged speed of 25 knots, had not then, however, got beyond the design stage. The Royal Navy and the United States Navy used the German U-boats to carry out exhaustive trials with this Walther cycle engine, as it is called, after the name of the inventor, in the hope of improving its reliability and performance; but the construction of a Walther cycle engine submarine, ordered by the United States Navy some four years ago, was not proceeded with. Not only were the Americans far from satisfied that the engine was satisfactory, but by that time an atomic power plant for underwater vessels was becoming a practical possibility and they at once switched over to this new source of energy. Two submarines with atomic power plants and steam turbine engines are now under construction and Admiral Carney, Chief of U.S. Naval Operations, recently asked Congress for authority to lay down a third during the fiscal year July, 1954-55. Each of these three submarines, it should be noted, will try out a different type of reactor. The first of them—the "Nautilus"—is reliably reported to be of over 3000 tons displacement and to have a submerged speed of between 20 and 28 knots. Her very high underwater speed and endurance—the latter limited only by the endurance of her ship's company of about ninety officers and men—give her operational advantages of the highest order. For the dependence of submersibles on storage batteries has hitherto been the greatest single factor in limiting their submerged performance. None-the-less, these revolutionary vessels will have obvious disadvantages, apart from their immense cost—about £18,000,000 for each vessel. Officers experienced in submarine operations are not in favour of a very large submarine, which is a much easier target for "Asdics" and, with its large turning circle, is far less handy and manœuvrable in emergency. Nor is it by any means certain that prolonged high speed and endurance submerged are essential requirements for submarines of a naval power which has the surface control of communications. The higher their speed the more numerous will be the targets intercepted and the more difficulties will an "Asdic" vessel have in chasing and destroying them. But this does not necessarily require that high speed must be maintained for days on end.

The Admiralty may be relied on never to give any information about H.M. ships under construction until quite certain that it can no longer be of any possible use to our potential enemies. But the meagre details of the new British submarine "Explorer," announced at her launching at Barrow-in-Furness early in March, indicate not only that we have met with fewer difficulties than the Americans in building propulsion machinery which uses hydrogen peroxide, but also, as we have suggested above, that an atomic power plant may not necessarily be the best power plant for a true submarine. In the guarded words of the Admiralty communiqué, "the 'Explorer' is designed to operate at high underwater speeds and has propulsive machinery of novel design employing hydrogen peroxide." Hydrogen peroxide requires special storage on account of its explosive propensities in conjunction with inflammable materials. Limitations of space set bounds to the vessel's endurance. But there should be no difficulty in carrying, with safety, sufficient for whatever periods it may be necessary for the vessel to continue proceeding at high speed submerged. No information is given of the speed of "Explorer," but if she has two engines, the German estimate of 25 knots should not be far wrong. The "Explorer" has also the great advantage of being much smaller than the "Nautilus." Her length is, in fact, only 225ft—some 50ft less than the 1300-ton "Tallyho." It will thus be of great interest to compare the performance and operational value of the "Nautilus" and "Explorer" during peace-time exercises over the next two years. One can but venture the opinion at this stage that an atomic power plant may well prove of much more value for task force ships, and other surface vessels operating overseas, than for submarines.

METALLURGICAL EDUCATION

All who are concerned with metallurgical education, and especially those who are interested in the engineering aspects of metallurgy, will find much food for thought in a paper on "The Nature of Education in Metallurgical Engineering," by Dr. Robert F. Mehl, head of the department of metallurgical engineering in the Carnegie Institute of Technology, Pittsburgh, read before the American Institute of Mining and Metallurgical Engineers and published in the June number of the *Journal of Metals*. Dr. Mehl defines metallurgical engineering as "that composite of learning and of abilities-to-do that is generally recognised, primarily in the industry, as of consequence to those who call themselves metallurgists or metallurgical engineers"; and, in devising appropriate training, he attaches importance to "those matters, scientific and engineering, which the leaders of industry confidently believe will be of importance to the industry in the near future." He emphasises that a metallurgical engineer is neither a chemist nor a physicist though basic physics is a

foundation stone to him; and he regards metallurgical engineering as "a thing-in-itself, with a unique body of material and of method, and certainly of ultimate general aim."

We have often suspected that certain educational principles that have long ago won acceptance in this country are less well-established on the other side of the Atlantic. One part of Dr. Mehl's paper confirms that suspicion. For nobody here, other, perhaps, than a raw undergraduate, would even think it possible to train a student in such a way that he can accept full responsibility as an engineer in industry on graduation. Nor does it seem at all necessary nowadays to repeat arguments against any attempt to base an education on current technologies. The need to confine education to "fundamentals" using current technologies only as examples of their application, has been so long preached that it is nowadays accepted as a truism. When, however, Dr. Mehl turns away from this somewhat threadbare theme and confines his discussion more closely to metallurgy he has much more of interest to write. He draws, for example, a distinction between a training in the science of metals and a training in metallurgical engineering. He favours the latter because "progress in the science of metals has so often come from those, granted with good fundamental training, who have been able to tap the magnificent source of phenomena that is on display in industry." He holds that in its extreme form training only in the science of metals "perverts into training in the physics of metals." He goes on to remark: "There is a disease abroad in this, to which metallurgists, especially graduate students, show a wholly ill-advised, unnecessary vulnerability. I doubt that so many words have been written with so little result, that integral signs have ever been more profligately expended, that so little experimental verification has ever been attempted, as in the pursuit of the elusive dislocation." The metallurgist has his own field and, he asserts, it is he who has largely built the science of metals. It is, perhaps, as well that Dr. Mehl at this point puts in a disclaimer acknowledging that those "who properly profess the physics of metals" have contributed to advances and that metallurgists "have always benefited by those in any science who have studied metals." But quite reasonably he asks that metallurgical schools should turn out good metallurgists rather than physicists.

After broadly outlining a metallurgical curriculum, Dr. Mehl turns to the preparation of the student for his future environment. The student must learn "enough about research to be able to work with research men with understanding, even if he is not one of them himself." He also remarks that an opportunity to grasp a long-range view of metallurgy in the industry is as much a part of education as learning the phase rule. But he is deeply critical of the visiting of industrial plants by students unless the visits have been educationally planned. "Simple visiting is a fearful waste of time." There is, too, a truth going far beyond the confines of metallurgy in the statement, "The good professor of metallurgical engineering must respect, and if competent will not be able to avoid respecting, what his industrial associates think of education." But "the full responsibility is his..... he must resist any pressure to teach a host of specialised and descriptive courses, chiefly on principle, and also because of utter impracticability." Perhaps professors in America are less steadfast upon that point than we know professors here to be. Indeed, for this country, the more apposite comment might be that professors should make themselves better aware of what industrialists are thinking. There are many other points of interest in Dr. Mehl's paper, including some remarks on graduate students and post-graduate research. His comments, always forthright and often provocative, come particularly appropriately at this time when the establishment of "technological colleges" is under discussion in this country. For metallurgical engineering is a technology and in drawing the distinction between it and the science of metals Dr. Mehl is in reality discussing a technological as opposed to a scientific education. He shows that, even though biased towards particular industrial needs it can be and should be just as fundamental.

Literature

Information Theory. By S. GOLDMAN. London: Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 50s.

THE title of this book, *Information Theory*, is a term used more commonly in the United States (Mr. Goldman is Professor at Syracuse University) for the subject of "Statistical Communication Theory," as it is known in this country. Since R. V. L. Hartley* published his original paper in 1928 there has been increasing attention given to the concept of information—how to define it; how to measure it quantitatively. These considerations came to full maturity some five years ago, in the now classic work of Wiener† and Shannon,‡ and, since that work, there have been widespread interpretations and applications in this country,§ in the U.S.A., and in Europe. Strange as it may seem to some engineers, information, scientifically speaking (i.e. quantitatively), is closely related to Boltzmann's entropy as interpreted in statistical mechanics, and is measured as the expected value of the log-probability of the state of a source—not a thermodynamic system, but an "information source."

Now "information" is a concept and a term widely used. Our telephones, telegraphs and radios transmit and receive it; our filing systems store it; our calculating machines and data-handling apparatus process it and operate upon it. The modern world could not continue one day, except through the vast complex of communication systems which it largely comprises. In common parlance we speak of useful information, valuable, precise, timely misleading information and so on. The mathematical measure has nothing whatever to do with these aspects, and does not touch upon such semantic ("meaningful"), or pragmatic (value, use ... to specific users) interpretations, but concerns only the syntactic properties, or properties of the sign or signals themselves, *per se*—their relative frequencies of occurring in the source, their preferred sequences, &c.

In this book, the author covers the material presented in Shannon's classic work in a detailed and thorough way, greatly expanding much of the original theory and giving a number of new derivations and interpretations. Your reviewer has only one slight quarrel, which concerns Professor Goldman's repeated reference to "language as a code." Language is nothing of the kind, and the theory of communication has really little to do with human language. Professor Goldman is, of course, quite clear about this himself, but could afford to have avoided reference to human language in the beginning of this book, since this may tend to set the reader in a wrong frame of mind, at the start.

The distinction is drawn between "continuous" and "discrete" signals (not *discreet* as a repeated misprint has it!), in the same way that Shannon indicated. "Continuous" sources of information are exampled by speech, television, analogue computors ... and "discrete" by print, by numerals, by digital computors. In a sense this distinction is artificial, and raises unnecessary complications. All sources of information can be regarded as discrete; continuity is a mathematical fiction, as probably Poincaré was first to indicate clearly.‖ All "continuous" data can be reduced to a finite set of discrete elements. If anything about a source is to be regarded as "continuous" it is the probability distributions of the source ensembles and, in real life, these can be only estimates, obtained from a finite set of past observations. But the distinction is now classical and Professor Goldman accepts it, and the consequent mathematical difficulty concerning the information rate of a source having an infinite number of possible states. This information rate turns out to be infinite, but again for somewhat artificial reasons. It is only infinite in the hypothetical case of a noiseless source; if noise be considered, however arbitrarily small, in the case in any physical communication system, this rate is seen to be finite, as the author in fact eventually shows.

To sum up, this book will appeal to the comparative newcomer to statistical communication theory, starting as it does from the (mathematical) beginning, especially to those interested in the theory not only in its engineering interpretations, but also as a general contribution to scientific method. Its flavour is mathematical, but not too offensively so. But then the theory is only comprehensible in such terms, and cannot be grasped by those who would avoid mathematics. Statistical Communication Theory is really an aspect of probability theory, and bears extremely close comparison with statistical mechanics.

Clock Cleaning and Repairing. Edited by Bernard E. Jones. London: Cassell and Co., Ltd., 37–38, St. Andrew's Hill, E.C.4. Price 4s. 6d.

ALTHOUGH this book has always been primarily intended for the instruction of those who have no previous knowledge of horological subjects, its many earlier editions have contained a good deal of information that is useful to all who are interested in, or concerned with, clocks. This new version has taken account of most up-to-date features of design in many kinds of mechanical clocks, and also includes some informative chapters on the various types of electrical timekeepers that are now so widely used. Most of the text has been rewritten

* R. V. L. Hartley: "Transmission of Information," *Bell Syst. Tech. Journal*, 7, August, 1928, page 535.

† N. Wiener: *Cybernetics*. John Wiley, N.Y. 1948.

‡ C. E. Shannon and W. Weaver: *A Mathematical Theory of Communication*. University of Illinois Press, Urbana, U.S.A. 1949.

§ See, for example, W. Jackson: *Proceedings of a Symposium on Communication Theory*. Butterworth Scientific Press, London.

‖ Poincaré, H.: "Science and Hypothesis."

and all the photographic illustrations are new.

After explaining the principles, construction and operation of a simple timepiece, and detailing the tools required for normal repair work, the book gives instruction on the method of cleaning the simpler types of clocks, and then goes on to deal with Dutch and French clocks. The intention is to familiarise the reader with clock mechanism before giving instruction in actual repair work. The descriptions of various parts of clock mechanism have been kept clear and concise, and care has been taken to explain the purpose of the various parts and assemblies that bear special and unfamiliar titles.

The chapter on repair work, which follows those on cleaning, not only gives a considerable amount of careful instruction, but also, wisely, indicates the limitations of those who lack the long practice of the experienced craftsman. The parts of a clock that usually perplex the beginner, such as the escapements, striking and chiming and alarm mechanisms, stopworks and other components, are covered in the succeeding chapters, and here, as in the earlier parts of the work, the illustrations are clear and good. The system of giving reference letters, and their respective part titles, in the captions to the illustrations, and of excluding them from the text, has been adopted, and this does seem better than imposing on the reader the rather laborious task of continually turning from text to illustration and back again.

It is good to see that, despite the modernisation of the book, the familiar long-case, or "grandfather" clock, which is such a prized possession in many homes, has been given a chapter to itself. This chapter also describes the action of the "moon" attachment, that is so often inoperative because its action is not fully understood. The new chapter on synchronous electric clocks is decidedly good, and begins, as it should, with a description of their principles of operation. Most of the popular makes are covered in the ensuing pages, and this section is well illustrated.

One of the most interesting parts of the whole book is that dealing with electric master clocks. The increasing popularity of this form of clock, both as the master-timekeeper for a circuit of dials in large buildings, and as a "regulator" for horologists, coupled with its remarkably fine time-keeping capabilities, make an understanding of its action a necessary part of horological instruction.

A good index rounds off a handbook which, despite its small size, and the fact that it cannot be more than an introduction to the fascinating subject of horology, does contain a surprising amount of information for its size, and should serve to arouse in many readers a desire to pursue the subject further in more advanced works.

Les Mines de Fer Françaises. Société des Hauts-Fourneaux de Saulnes. Jean Raty et Cie, Paris. 8, Place d'Ièna (16e).

FRENCH iron ore production in 1953 totalled 42,500,000 tons, a figure exceeded only by the United States, which produced 95,500,000 ions. During that year the Russian production of iron ore almost equalled the French, the three next largest producers being Sweden, Great Britain, and Germany, which produced about 17,000,000, 16,000,000 and 15,000,000 tons respectively. These figures are given in *Les Mines de Fer Françaises*, a volume which reviews iron ore mining in France, and gives many statistics of production, consumption, and so on. The volume is published in French; the first part reviews the various French iron ore centres—Lorraine, the West and the Pyrénées, and gives an account of the technical, economic and financial conditions of the industry. The various modernisation programmes undertaken since the war are described, and their results are discussed. The second part of the volume is entirely statistical. An impressive modernisation programme has been in progress since the war, and it is pointed out that the mechanical loading capacity of the eastern mines has been increased fivefold since 1947.

Fundamentals of Structural Analysis. By A. A. JAKKULA and H. K. STEPHENSON. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 33s. 6d.

THIS is a book really written for students. The beginner can start at page 1 and work his way through to the end without the aid of additional reference books or tutor. Very little demand is made on previous knowledge beyond a few simple principles of elementary mechanics. Yet within the limits set of statically determinate structures, the book is very complete and gives the student all he need know to solve roof and bridge trusses, columns and simple portals.

The book comprises fifteen chapters dealing with systems of coplanar forces, dead, live and wind loads, roof and bridge trusses, beams, girders and columns, the analysis of statically determinate portals and arches. Node displacements are mentioned only in connection with columns and no reference is made to deflections in roof or bridge trusses. The authors give about equal weight to graphical and analytical methods. This is a wise step since beginners usually prefer graphical methods to start with as these help them to visualise both structure and system of forces, but later, with practice, give preference to analytical methods which are faster and more accurate. Considerable space is devoted to the analysis of girders and bridge trusses by influence lines and by the method of criteria, a simple means of determining critical loading and the corresponding conditions of stress.

The book is well planned and contains a number of carefully chosen and worked-out examples and problems. The subject matter is both clearly and concisely dealt with and the numerous line diagrams are well drawn. It is a textbook for first-year civil engineering students, well worth its price, especially for those who cannot follow a full-time course and who intend to do some reading on their own.

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

FAIRGROUND MACHINERY

SIR,—I have read with great interest Mr. P. W. Bradley's articles on "Fairground Machinery," and have often wished for a description of the early attempts of a mechanical roundabout before my time. I well remember one of the great wonders of the time. A locomotive about 2ft 6in gauge, outside cylinders, single driving wheels, boiler lagged with wood, and the usual polished brasswork. The track was on trestles, 6ft from ground and about 60ft diameter. The engine pulled six coaches each, taking six passengers, and was built by Savage, King's Lynn. The driver and owner put in every night and Saturdays from 12 a.m. to 12 midnight, his wife and helper fetching water and pumping it up to engine tank, and then dismantled and hauled to next fairground. And all for 1d a ride.

The men with sideshows, shooting galleries, had small engines, the last I saw was driving a dynamo at an early cinema.

I never heard of any accidents, for they were erected quickly and got things moving, with the paraffin lamps and the coughing and spitting of the early arc lamps.

Please excuse me writing, but your description reminds me of my early days at a small engineers.

J. HILTON

Eastbourne, August 5th.

Report of the British Rubber Development Board

CONTINUED progress on rubberised roads was reported in the British Rubber Development Board's annual report for 1953. During the year fifty-nine rubberised roads were laid in countries throughout the world. The report noted that conclusive proof of the advantages of rubberised roads could best come from actual wearing tests, scientifically controlled and carried out under impartial authority, and in this connection it stresses the importance of the co-operative research scheme between the Board and the Road Research Laboratory at Harmondsworth. During the year three further trial roads were laid under this scheme—a surface dressing trial; a test to determine the value of rubberised bitumen in preventing the cracking which usually appears in a surface which is laid over concrete joints; and a small-scale trial of rubberised mastic asphalt. The report mentioned that the road authorities of Penang, Malaya, announced that all its future roads would contain rubber, and that in the United States of America a survey carried out in 1953 revealed that 67 per cent of the road officials interviewed would recommend the laying of a rubberised road if funds were available. The report concluded by noting a number of new uses for rubberised bitumen which have been investigated during the year, e.g. pipe linings and playground surfaces, and a further test carried out using latex with cement for soil stabilisation—an application considered to have good potentialities for low cost roads.

Fifth International Astronautical Congress

(Contributed)

AMERICAN rocket engineers claim that they already have the necessary motors and missile structures for establishing an unmanned satellite vehicle. Dr. Levitt, of the Franklin Institute, suggests that the artificial satellite should accordingly be established in the next few years. He says that it would pay for itself by having use to geophysicists. Uninstrumented, it would consist of a reflecting sphere which could be observed as a bright star from the earth's surface. Orbital perturbations would give variations of the value of "g" over the earth and could be used to locate mineral and oil deposits.

The uninstrumented satellite would also furnish a basic tool for large-scale triangulation and the determination of the oblateness of the earth.

Dealing with more practical problems, H. H. Koelle, of Stuttgart, stressed the importance of turbo-pumps in large rockets. They are often called the heart of the rocket motor because they determine the thrust rate. Turbo-pumps are operated by steam or combustion gases. It was shown that a two-stage Curtis turbine is an economic solution for burning times of the order of 100 seconds. As the efficiency of turbines plays a deciding role when burning times are long, it was concluded that multi-stage gear turbines are the best type when the period of operation becomes of the order of one hour.

R. Kieffer and F. Benesovsky, of Reutte, said that sintered materials would become as important as high heat resistant alloys and permit higher working temperatures. Materials to be used at high temperatures must be scale resistant as well as strong, and they must not fail under thermal shock. Super alloys based on

nickel-chromium and cobalt-chromium to-day allow temperatures up to 870 deg. Cent. The use of high melting point metals such as molybdenum, tungsten, tantalum, &c., is impossible because of their poor resistance against oxidation when heated in oxygen-rich atmospheres. Among sintered materials, carbides based on titanium carbide, with binders of nickel-chromium-cobalt have proved useful. From recent American reports, zirconium boride is one of the best materials for nozzles. Some silicides, especially molybdenum di-silicide, show a good scale resistance. Shaped pieces manufactured from this material can be heated in the open air to a temperature of 1700 deg. Cent. without showing any noticeable alteration.

The use of silicides as material for turbine blades is restricted because of its relatively great brittleness. High melting oxides as well as combined alloys between metals and metal oxides might also prove uncertain because of brittleness and bad thermal shock properties.

Some papers showed that electrical methods of space-ship propulsion may be feasible and will save fuel for interplanetary journeys. But these ion rockets could not operate in an atmosphere and will accordingly only be of academic interest until the brute force of chemical propellants can get man into space.

Short Notice

Model Analysis of Structures. By T. M. Charlton. London : E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, W.C.2. Price 21s.—The theoretical principles and techniques of using scale models for analysing structures with linear load/deflection characteristics are outlined in this book. The theories of the direct and indirect methods are considered in the first three chapters, together with variations of the indirect method, based upon the principle of virtual work, whereby it can be used for structures with non-linear load/deflection characteristics. Examples of the use of both methods are then given, and there is an account of a method, due to the author, making use of the " isodynamometer."

Books Received

A Treatise on Applied Hydraulics. Fourth edition. By H. Addison. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 56s.

Hydraulic Systems and Equipment. By R. Hadekel. London : Cambridge University Press, Bentley House, 200, Euston Road, N.W.1. Price 18s.

Engineering Contracts and Specifications. Third edition. By R. W. Abbett. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 48s.

Laplace Transforms for Electrical Engineers. By B. J. Starkey. London : Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 30s.

Electric Traction. Third edition. By A. T. Dover. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 60s.

Crystal Rectifiers and Transistors. Consulting Editor, M. G. Say. London : George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 21s.

Guide to the Coalfields, 1954. Edited by R. H. Walkerdine. London : The Colliery Guardian Company, Ltd., 30 and 31, Furnival Street, E.C.4. Price 20s.

Relaxation Methods. By D. N. de G. Allen. London : McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 53s. 6d.

Application of Results of Research. Compiled and edited by Vera Connell. London : Butterworths Scientific Publications, Ltd., 88, Kingsway, W.C.2. Price 21s.

Drawing, Sketching and Blueprint Reading. By S. L. Coover. London : McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 32s.

Metals Engineering Design. Edited by O. J. Horger. London : McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 72s. 6d.

Theory and Design of Steam and Gas Turbines. By J. F. Lee. London : McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 64s. 6d.

Imagination and the Railway Industry

(Contributed)

IT has long been manifest that the railway industry—we refer in particular to its passenger transport branch—has clamant need to put forth every effort, practical and imaginative, whereby traffic can be attracted. The inducements offered by the airlines grow ever more persuasive, and were speed the only consideration these inducements would become conclusive. Speed is not, however, the only consideration, and the railways possess resources which, adequately developed and publicised, should be beneficial both to the industry and to those who are its potential customers. For example, an aspect of railway travelling which should not be overlooked is the means thus provided whereby the passenger can see and enjoy much that remains invisible to the traveller by aeroplane. Moreover, the richer the scenic beauty and historic interest of the region traversed, the greater may be the benefit to those who journey by rail. One can travel at 7 miles a minute over the Atlantic without any sacrifice of that interest which comes from the contemplation of historic scenes. Overland, however, the situation may be entirely different, and we have to choose between ultra-rapid air transport and the satisfaction of seeing something of the places through which we pass. An illustrative example occurs on the Midland Region of the British Railways, where the proximity of the line to the route of the Roman road called Watling Street is such that the Roman road is crossed by the railway three times between Euston and Rugby. The historic and æsthetic interest of any given territory is something which, unfolding before the traveller by train, is lost to the traveller by aeroplane. How memorable, for example, is the train journey from Stirling to Oban and how the passenger longs—even at moderate railway speeds—for just a little more time to enjoy its loveliness. Again, what memories are roused when we see the name " Severus Junction " on the signalbox at York and how unforgettable is the sight of Lincoln, York or Durham seen from the train ! The passenger by train buys not only comfortable transport but the means of adding to his pleasure by contemplating the beauty and interest of the country through which he is passing.

The recognition of this valuable feature of railway travel calls for publicity and reference can here be made to a type of publicity which, found on the German Federal Railways, appears to be extremely well worth emulation by the British Railways. This consists of the distribution, throughout the train, of small leaflets detailing the route, the timetable and the connections available at each stopping place. We have before us the leaflet relating to train F53, the " Domspatz," which runs from Passau to Hamburg-Altona, via Regensburg, Nürnberg, Würzburg, Bebra, Göttingen, Elze and Hannover. This 9in by 9½in leaflet is printed on very thin paper and details, *inter alia*, the amenities of the train, such as the " Schreibabteil," where passengers can dictate letters to the travelling lady secretary (" Zugsekretärinnen ") and have their correspondence typed and posted *en route*. Other information given by the leaflet includes particulars not only of all connections, but of the types of trains and the times at which the connecting trains arrive at their destinations. For example, ten trains are shown radiating from Nürnberg after the arrival there (at 8.41) of the northbound " Domspatz." The leaflet carries a certain number of advertisements, which do not in any way detract from its clarity and doubtless pay for its cost. Prominently printed below a photograph showing part of the train are the words : " Wir wünschen Ihnen gute Fahrt ! " (" We wish you a good journey "). This sort of publicity not only interests the long-distance passenger, but familiarises him with the transport system and its timetable. What we need on the British Railways is similar publicity distributed, not in thick and expensive brochures, but in thin and inexpensive leaflets such as those found in the crack trains of the Deutsche Bundesbahn. It is not only the information as to travelling times and facilities which must be effectively publicised. The railways should make known to the passenger (or potential passenger) something of the places through which he will pass. We have mentioned—as illustrative examples—one or two glimpses obtained from the British railways, and rich indeed are the resources of our countryside, whether in scenic beauty or in historic interest. These resources should be made known with the utmost efficiency, brevity and clarity so that the potential passenger—whether he be a native or a visitor from abroad—may become aware of the strong inducement offered by that visibility which can be so precious an element in railway travel. It is the same wherever railways traverse regions which are charged with historical interest or æsthetic beauty. There are, indeed, many regions rich in both and we may mention, as a Continental example, the wonderful territory between Milan and Naples, which can be seen in unsurpassed comfort by passengers using the superbly equipped Elettrotreni ETR 300. Looking out from the observation windows of this remarkable train, the traveller is able to enjoy not only the constantly changing panorama of rivers, forests and mountains, but impressions derived from the sight of historic places and monuments.

That rail and air transport—like sea and road transport—are essential elements in our civilisation needs no stressing. They have, however, their own distinctive advantages and from the standpoints both of public utility and national economy these various transport systems should be so developed and publicised that they become helpful rather than hostile to each other. To the engineering industry it is surely of vital importance that the railway industry shall remain strong. To maintain this strength demands constant and imaginative vigilance on the part of the railways. Let us not forget that on the prosperity of the railways depends the prosperity of the locomotive builder, the manufacturer of railway diesel engines, of rolling stock, bridges, signalling equipment, railway accessories, and—not least—of electrical traction equipment. Thus it is that to the British Railways there comes the clear call—the more resonant by reason of nationalisation—to truly imaginative effort directed, not only for the benefit of the travelling public and the solvency of the railways themselves, but to the maintenance and expansion of the national industry.

"SERAPHIM" EXTENSIONS AT APPLEBY-FRODINGHAM STEELWORKS

Fig. 1—Screening end of the tertiary crusher building. The building also contains six hammer mills, three each for Frodingham and Northampton ore

Fig. 2—Sinter materials storage building. There are bays for storing Frodingham ore and Northampton ore and coke breeze

Fig. 3—Interior of sinter house. Between the sinter strands on each side the control room is visible in the background

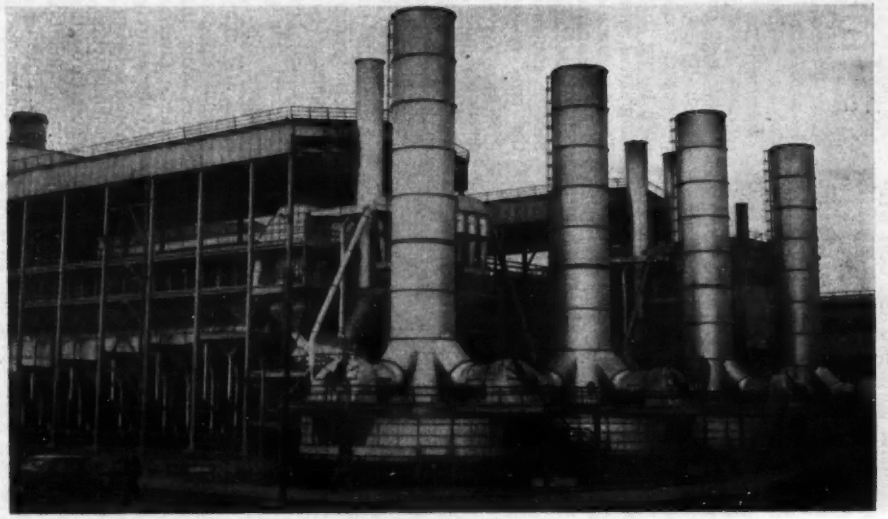


Fig. 4—Sinter plant. Four sinter coolers are prominent

"Seraphim" Extensions at Scunthorpe

The output of the Appleby-Frodingham iron works has been increased from 900,000 *tons per annum to* 1,250,000 *tons by the construction of two new blast-furnaces, one with a hearth diameter of* 28*ft* 6*in, and ancillary plant. The furnaces operate on burdens as high as* 100 *per cent sinter and major items in the new plant are ore crushing machinery and a sinter plant.*

THE "Seraphim" project for the extension of the Appleby-Frodingham works of the United Steel Companies, Ltd., of which the official opening was recorded in our last issue, had its birth in the desire to expand the pig iron production of these works from about 900,000 tons per annum to 1,250,000 tons, whilst abandoning certain obsolescent plant. But extensions involved more than the construction of additional blast-furnace and auxiliary plant, more even than adopting new furnaces of improved design and larger hearth diameter. For as the years have passed and the local ores used at the works have been further and further excavated, their quality has deteriorated. Sulphur content has risen by the order of 0·4 per cent and iron content dropped by 1 per cent in a total iron content of barely 20 per cent in the Frodingham beds, from which about two-thirds of the iron ore needs of the works are drawn. The chemical quality of the Northamptonshire ore that makes up the remaining one-third has deteriorated less. But the physical quality of both ores has been steadily changing. The percentage of fines has increased, and seems likely to continue to increase. It already stands at some 50 per cent. Short of discarding, therefore, half of all the ore mined, a wholly uneconomic proposal, ore preparation by sintering, a process of which experience had already been gained, had to be adopted in the new extension. In the result, the most notable thing about the new plant is not the large hearth diameter at 28ft 6in of the second of the two blast-furnaces included in the extension, but the fact that this, the "Queen Victoria" furnace, will operate on a 100 per cent sinter burden. It is believed to be the first blast-furnace in the world to do so.

Important advantages are expected to follow. Sintering removes the volatile content of the raw materials and this action has a profound influence on both the production and fuel rates of a blast-furnace. In addition, a particularly important effect as the sulphur content of the ores is high, about 70 per cent of the ingoing sulphur is driven off in the sinter plant. In consequence, the use of nothing but sinter in the blast-furnace not only reduces coke consumption per ton of iron produced, but also the sulphur content.

Before, however, the adoption of a 100 per cent sinter burden could be contemplated, much research had to be done into methods of making a satisfactory sinter from the Frodingham and Northamptonshire ores. For the sintering of these ores, which have a high volatile content and up to 20 per cent of lime in the finished sinter is a very different proposition from that of sintering richer ores. Lime, in particular, was found to have a deleterious effect upon the mechanical strength unless the raw materials for the sinter plant were crushed to $-\frac{1}{4}$in; its effect was aggravated by using water cooling of the sinter. In the new plant, therefore, three stages of crushing have been provided for the ores instead of the more usual two; and the sinter is air instead of water cooled.

On the blast-furnace side, experience with existing 22ft furnaces showed that when using only 33 per cent of sinter, blowing pressure could not exceed 16 lb per square inch. When, however, a 100 per cent sinter was experimentally used in a 25ft furnace, good operation was revealed up to 22 lb per square inch, the highest figure obtainable. Thus, for the newer furnaces, blowing plant capable of maintaining a satisfactory flow up to 30lb per square inch was ordered, and it is probable that in making further extensions of the blowing plant, even higher pressures will be called for. For the 27ft "Queen Anne" furnace, the first to be completed of the two "Seraphim" furnaces, has been operating very satisfactorily at pressures up to 28 lb per square inch. Close investigation is, we understand, being made of the possibility of using gas turbine driven plant for this purpose.

Since very full descriptions of the new plant have already been published elsewhere, we do not intend here to go far into detail. Rather we shall draw attention to matters of particular interest.

Crushing Plant

The new crushing plant, Fig. 6, operates only on Frodingham ore, Northamptonshire ore being crushed elsewhere. It has a normal rating of 700 tons an hour and is contained in a building 480ft long. The primary crusher, supplied by Hadfields, Ltd., has two rolls 6ft dia. by 5ft wide, with a minimum setting of $4\frac{1}{2}$in, and there are two 5ft 6in Symons cone crushers for secondary crushing, with a minimum setting of $1\frac{1}{2}$in. An inclined Ross car haul, which engages the ore wagon coupling links, leads to a side discharge wagon tippler of 45 tons capacity and 70 deg. tipping angle, built by Fraser and Chalmers, Ltd. Below the tippler hopper there is a Ross drop bar grizzley which discharges on to a two-roll grizzley, followed by the primary crusher. Below this crusher another drop bar grizzley screens out the fines and discharges the large material on to a two-roll grizzley screen. The ore which needs secondary crushing is thus separated here

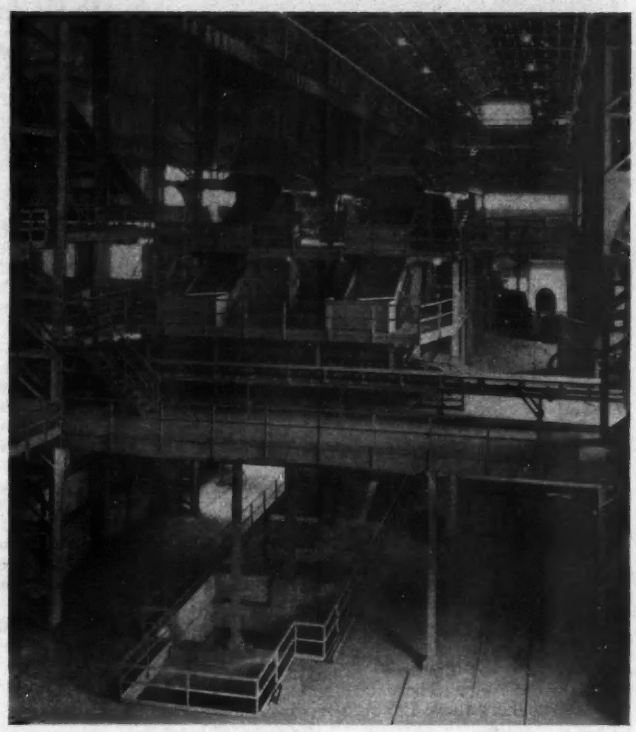


Fig. 6—This building contains the primary and secondary crushers with a normal rating of 700 tons of Frodingham ore per hour

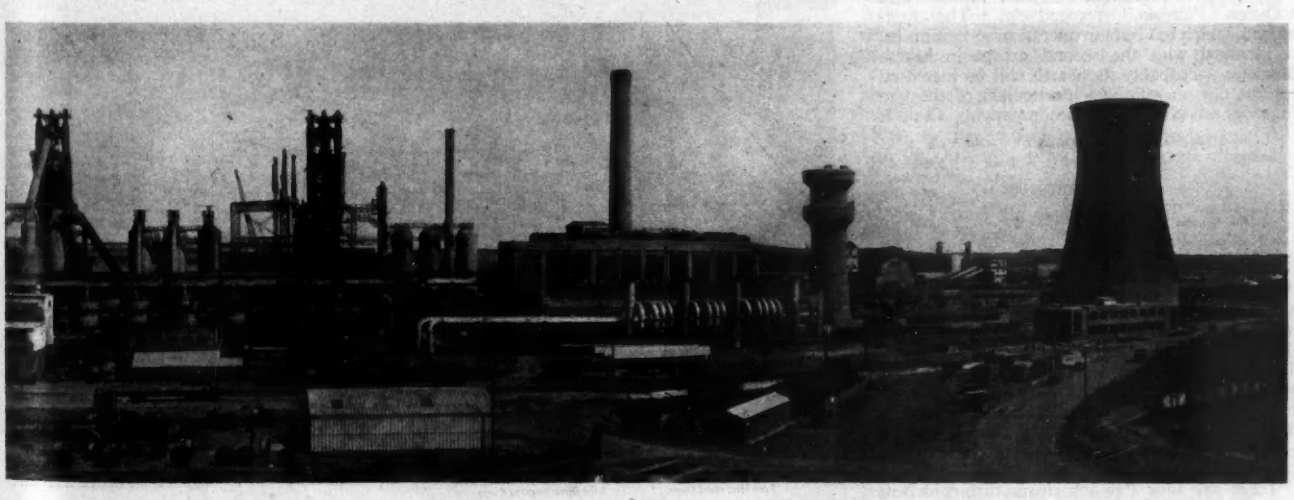


Fig. 5—Panoramic view of "Seraphim" from the west. The two blast furnaces and ancillary equipment, the blower house and the cooling tower are prominent The sinter plant can be seen in the background

Broad collecting conveyors are used under all these units, with heavy shock-absorbing idlers where desirable, and the lump ore is fed by a single roll feeder on to a 60in belt conveyor leading to the secondary crushers. A movable feed box distributes the ore to either or both crushers.

The small-sized ore is separately conveyed by a 60in conveyor to the secondary crushing station, though it is not passed through the crushers. It is discharged by short conveyors on to either, or both, of two 48in conveyors, which receive the secondary crushed ore and convey it to the secondary screening station. This consists of two banks of screens, each containing two 72in by 168in Gyrex screens in series. The station is a junction from which lump ore is conveyed to the bedding plant and fines to the "Seraphim" tertiary screens. The system is in duplicate from the two secondary crushers up to the tertiary screens, as by an arrangement of short collecting and distributing conveyors, the secondary screens can discharge the fines on to either, or both, of two conveyors leading to the tertiary screens.

Sinter Plant

Tertiary screening, Fig. 1, and crushing is carried out near the sinter plant building. There are three banks of screens, two for Frodingham and one for Northampton ore. Oversize—that is over ¼in—material goes to six Fraser and Chalmers hammer mills. Conveyors which carry the undersize from the tertiary screens, pass below the hammer mills, pick up the crushed material, and carry the whole to the sinter materials storage building, illustrated in Fig. 2. This building contains ferro-concrete bulk storage pits for the two ores and coke breeze, and a series of steel bins along one side for mixture preparation. Newell circular feeder tables for ore and Lea Recorder meters for coke lie below the bins and feed material on to two belt conveyors, each serving a pair of sinter machines. Thence, the material goes to primary and secondary Newell mixers, which feed the sintering machines. There are four McKee-Head Wrightson sinter machines, Fig. 3, each 72in wide by 168ft long, with twenty-eight windboxes served by Howden suction fans, with a capacity of 300,000 cubic feet per minute at 26in w.g. suction. Hot sinter is discharged to a sinter crusher beneath which is a vibrating screen to return the fines to the sinter mixers. A cooler, Fig. 4, consists of a series of trays which carry hot sinter around a circular track. It was supplied by Lurgi Gesellschaft Fur Chemie und Huttenwesen. At one point, close to the feeding point, a dipped portion of the track causes one end of the tray to drop and discharge the cooled sinter into a hopper. Trays and track are enclosed above by a circular hood; and exhaust fans connected to this hood draw cooling air upwards through the hot sinter on the trays. The cooled sinter is conveyed to bunkers above the blast-furnace transfer cars.

Blast-Furnaces

There are two blast-furnaces within the "Seraphim" extension, "Queen Anne" and "Queen Victoria" respectively. The first-named, which has been in operation some months, is identical with the second except in hearth diameter. Probably its hearth will be increased to 28ft 6in on relining. Particulars of the two furnaces are given in the accompanying Table I.

Table I—*Blast-Furnace Particulars*

	Hearth dia., ft in	Bosh dia., ft in	Effective volume, cu ft
"Queen Anne" (No. 3) ...	27 0	30 3	42,372
"Queen Victoria" (No. 4)	28 6	31 9	44,351

Large bell diameter, 15ft; throat diameter, 22ft; height from taphole to top of hopper, 100ft 2in; from ground to bell platform, 121ft 3in; and from ground to top of bleeder davit, 224ft 4in.

A novel arrangement is the assembly of the staff and operators' offices and welfare rooms, with the instrument house in the centre along one side of the furnace building between the hoist houses. Though high top pressure operation has not been adopted the furnaces and gas cleaning plant have been so designed that it could be introduced at a later date.

Blowing Plant, &c.

There are four Parsons steam turbine-driven centrifugal blowers. Steam pressure is 425 lb per square inch at 740 deg. Fah., and the rated output 75,000 cubic feet of free air per minute at 30 lb per square inch gauge. Steam is supplied by four Thompson boilers, which can be fired with blast-furnace gas or oil fuel, rated at 85,000 lb of steam per hour at 450 lb per square inch and 760 deg. Fah.

Circulating water for the steam turbine condensers, the blast-furnaces and the gas cleaning plant is all cooled in a single "Davenport" tower, 183ft in diameter at the base and 265ft high from sill level. The cooling frames are divided into three sections so that each class of water is kept separate.

"Seraphim"

Explanation of the origin of the name "Seraphim" for the new extension gives us the opportunity to mention in a conveniently compact form the names of the principal contractors.

S. South.
E. Extensions.
R. Ross Engineers, Ltd.; engineering services for main ore crushing plant.
A. Ashmore, Benson, Pease and Co., Ltd.; engineering services, supply and erection of two blast-furnaces and ancillary equipment.
P. Parolle Electrical Plant Company, Ltd.; engineering services for the blowing plant and ancillary equipment; and C. A. Parsons and Co., Ltd., the blowing plant.
H. Head, Wrightson and Co., Ltd.; engineering services for sinter plant, supply and erection of four sinter machines, supply and erection of gas cleaning plant.
I. Idris } Christian names of Mr. I. M. Kemp, chief designer of the Appleby-Frodingham Steel Company, Ltd.
M. Miles }

Other main contractors were the United Steel Structural Company, which designed, supplied and erected blast-furnace stock bins, structural steel for buildings, gas and air mains, &c.; and Fraser and Chalmers Engineering Works, which supplied and erected conveyor equipment.

Reconstruction of a Shipyard

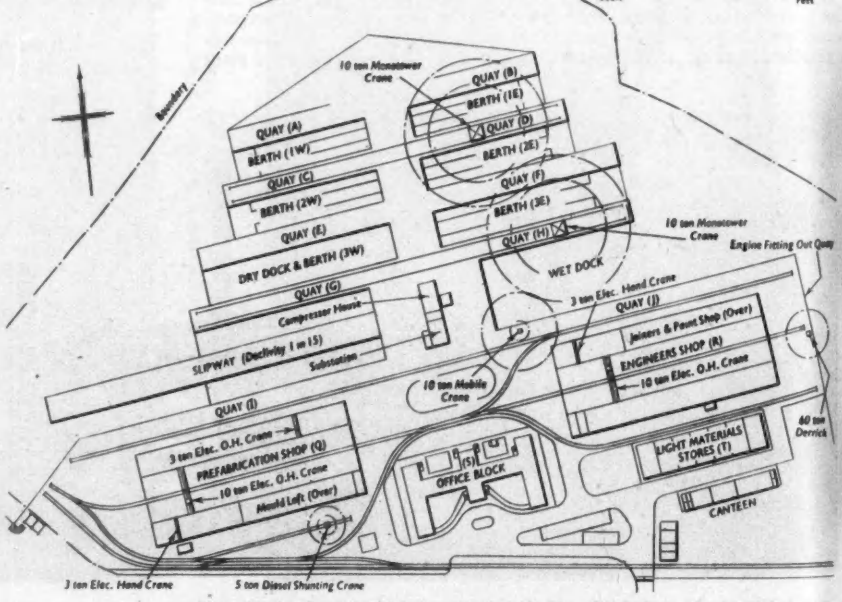
Work commenced in January last on schemes prepared, a few years ago, for the complete reconstruction of the South Yard of Brooke Marine, Ltd. The layout provides for five berths, one combined dry dock and berth, one slipway, and a wet dock, and the shipbuilding operations are based on the extensive use of prefabrication up to a unit weight of 10 tons. Reinforced and prestressed concrete is being employed throughout for the construction of building berths, quays and shops.

At present under construction and nearing completion is the completely redesigned and greatly enlarged South Yard of Brooke Marine, Ltd., Lowestoft, a company which is one of the Dowsett Group of Companies and was acquired by the Group just previous to the second world war. At that time only part of the present North Yard existed, and this was increased to its present size during the war, when the freehold of the South Yard was also acquired. This area together with recent additions now covers about 35 acres of what was mostly tidal swamp. During the war the yard was engaged exclusively on Admiralty work, so that a fresh beginning had to be made in commercial construction in the post war years. Three years ago a tentative scheme was drawn up for the development of the South Yard, and now, with sufficient orders in hand, it has been possible to carry out the scheme and work commenced at the beginning of this year.

Apart from the question of road and rail access, the scheme envisaged the building of ships on the basis of prefabrication of units weighing up to a maximum of 10 tons, and this factor decided the cranage capacity of the yard. Arrangements were made for engining the ships at the yard and the layout of berths was planned so that the minimum of cranes were required, while provision was made for the transport of units from the prefabricating and engine shops to the building berths by 10-ton and 20-ton trailers. The overall plan was for the yard to be able to build ships up to 280ft in length and to have a constructional capacity of twelve ships of maximum size or eighteen ships of about 200ft in length.

Description of Yard

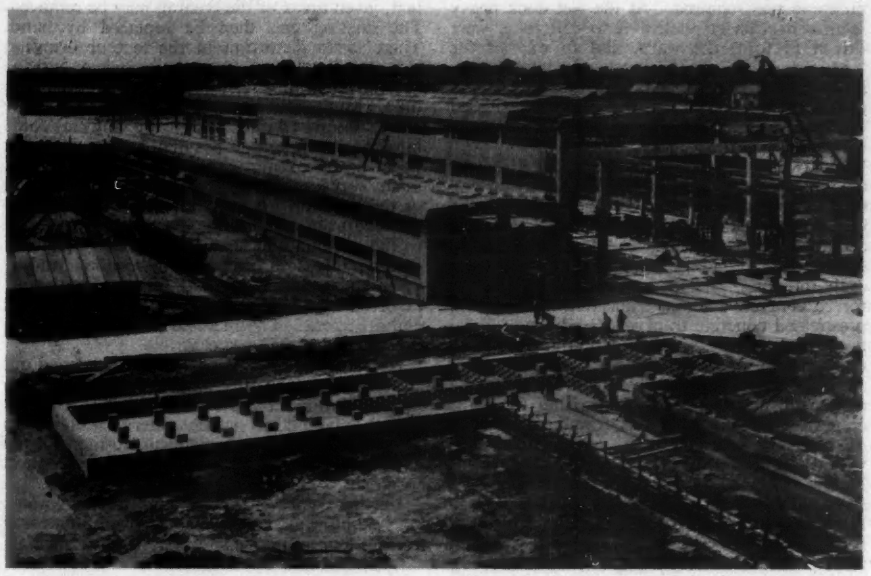
The site is on the south side of Lake Lothing, from which access to the sea is through Lowestoft inner harbour, which permits the passage of ships having up to 50ft beam and 18ft draught. As can be seen from the accompanying line



Plan showing layout of berths and shops in the shipyard

drawing, the layout of the yard is planned symmetrically about a line running approximately north and south. The berths lie on a line east to west, so that the ships will be launched upstream and downstream and so avoid the complications of launching towards the opposite bank. There are two berths, 225ft long by 50ft wide, to take ships up to 200ft in length, having 10ft 3in of water on the sill at the end of the launchway, increasing to 20ft. The next pair of berths are 255ft long by 55ft wide with 12ft 3in of water, the sill at the end of the launchway increasing to 22ft. These two berths are designed to build ships up to 230ft in length. A fifth berth is 322ft in length by 60ft in width, has 13ft 6in of water, the sill at the end of the launchway increasing to 22ft 6in, and can take ships up to 280ft long. All the berths, some of which can be seen under construction in our illustrations, have a declivity of $\frac{1}{8}$in per foot and a reinforced concrete decking, and the depths of water given refer to high water ordinary spring tide. In addition to the five main building berths, there is a combined building berth and dry dock capable of accommodating ships up to 300ft long. Provision has been made to exclude water from the berths during construction of the ships and for this purpose the sills and quay walls have been designed to take floating caisson gates which can be removed for launching purposes. For completing the ships afloat there is a wet dock, which has been dredged to a general level of 22ft 6in and to 25ft 6in below H.W.O.S.T. over a length of 280ft. There is 860ft of quay wall space and the dock will float vessels having a maximum draught of 16ft at all states of the tide. Adjoining the wet dock is the quay, at which the ships will be engined, and this has a length of 250ft and has been dredged to the same depth as the dock. Opposite the wet dock and facing west is a slipway which has a length of 525ft, a declivity of 1 in 15, and rises from a point 22ft 6in below H.W.O.S.T. The slipway is 40ft wide and has side slipping facilities over a length of 260ft at the inner end.

There are two main buildings serving the yard and these are the prefabrication and engineers' shops, each of which is 360ft long by 150ft wide and consists of a central bay 75ft wide and two side bays 37ft 6in wide. The former has a height of 41ft 6in to the roof beams and the latter a height of 20ft. In the prefabrication shop one of the side bays has an intermediate floor, which serves as a mould loft, while a similar arrangement in the engineers' shop provides space for the joiners' shop and a paint shop. Other buildings include the main stores, which are arranged on the multi-bay principle and have a length of 56ft and a width of 215ft ; a compressor house and substation measuring 114ft long by 28ft wide ; a canteen building ; a main office block, arranged with two side wings and a centre wing ; and other ancillary buildings.

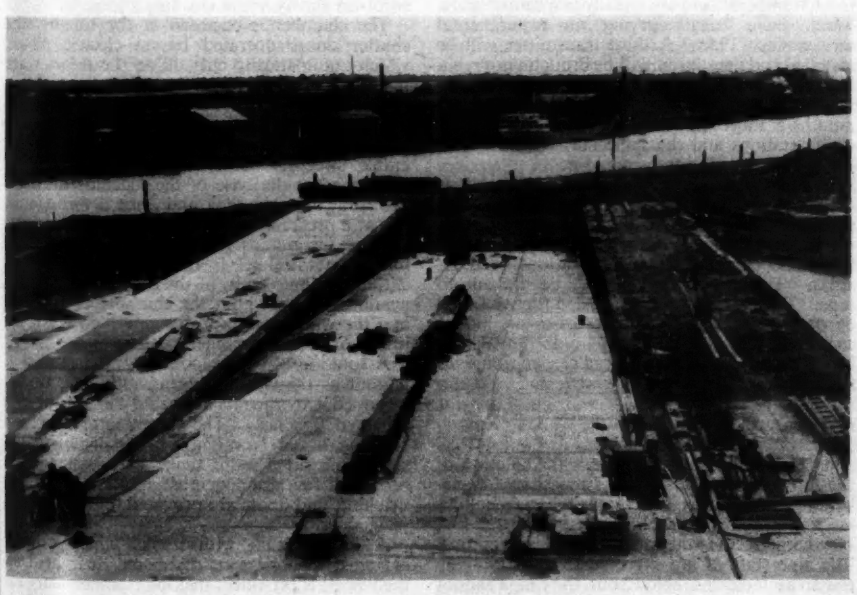


A general view of the prefabrication shop in which can be seen the end roof beam, the lintel beam, the main and side bay columns and the arrangement of cladding. In the foreground are the foundations of the office block

Services and Equipment

For serving the building berths, slipway, dry dock and wet dock there are two " Monotower " electric travelling cranes, each capable of lifting 10 tons at 80ft radius or 6 tons at 100ft or 3 tons at 120ft radius. A mobile crane rated to lift 10 tons at 14ft radius or 1 ton at 60ft radius is provided, while the engine quay is served by a derrick capable of a load of 60 tons at 40ft radius. For general purposes there is a travelling Coles crane having the capacity to lift 20 tons at 10ft radius or 5 tons at 30ft radius. In the prefabrication shop the central bay is equipped with a 10-ton electric overhead travelling crane, and the northern side bay has a similar crane of 3 tons capacity, while in the southern bay is a 3-ton travelling electric hand crane. The centre bay of the engineers' shop is provided with a 10-ton electric overhead travelling crane, and the northern side bay is served by a 3-ton travelling electric hand crane. For service in the steel stacking area and the railway sidings there is a rail-mounted diesel shunting crane, which can handle 5 tons at 16ft or $1\frac{1}{2}$ tons at 30ft radius.

In the prefabrication shop are all the tools and machines, including a 250-ton hydraulic joggling press, necessary for the fabrication of plates and bars into units weighing up to a maximum of 10 tons. A double-ended oil-fired bar furnace, capable of taking bars 42ft in length, is provided, and at each end are bending slabs adequate to deal with the frames required for the largest ship liable to be built in the yard. The marking-out, cutting, welding and punching of bars is carried out in the side bay under the mould loft, while similar work for the preparation of plates is allocated to the northern side bay. In the centre bay are automatic submerged arc welding machines and the shop is capable of an output of 300 tons of plate and bar per month. The southern side bay of the engineers' shop is fitted with woodworking machinery, arranged for handling shipwrights' and joiners' timber on production flow lines. In the northern side bay are located the fitters', electricians', plumbers' and coppersmiths' shops, while in the centre aisle are the heavy machine tools and covered accommodation for main and auxiliary machinery prior to installation on board ship. The substation is designed for an eventual capacity of 1500kVA, and welding transformers of 350A capacity for six and twelve operators are provided, together with suitable connecting points, to serve the berths, dry dock, wet dock, slipway, and shops. Initial requirements for compressed air are met by four 520 cubic feet per minute electrically driven compressors, and provision has been made for an increase in capacity of 50 per cent. The electricity, air and water services are carried in precast concrete ducts, and town's gas is provided for certain purposes in the engineers' shop. Some 2000 yards of railway sidings and track lie within the site boundaries to serve the shops, stores and dock quays. The track is mainly laid on Dow-Mac prestressed concrete sleepers.



Two of the building berths and quays under construction. To the right can be seen part of the wet dock

Constructional Details

Apart from the excavation work, the main civil engineering involved the driving of steel sheet piling to form the quay walls and the tying of them together with heavy steel walings and ties to take the lateral thrust from the filling and superimposed loads. Prestressed concrete bearing piles, varying in length from 20ft to 70ft, had to be driven at a number of points to take local loads. As a result of the use of prestressed and precast concrete units and by careful planning, about 70 per cent of the work was completed by the end of July, less than seven months after work commenced on the site. This consisted of various grades of sand with bands of gravel with the water table at about 20ft above the lowest excavation level, so that continuous

pumping was required. At the wet dock heavy section steel sheet piles, 41ft to 45ft long, were driven to form the walls, and in way of the "Monotower" crane supports, the launchways, and at the main bases of the fabrication and engineers' shops, 12in by 12in prestressed concrete piles, 25ft, 30ft and 35ft long, were driven.

The two main shops, one of which we illustrate, are of identical structural design embodying prestressed and precast concrete units ensuring the minimum amount of site work and, it is stated, economy in overall cost and low maintenance costs. Each building consists of twelve bays, each 36ft long, and the construction is of reinforced concrete columns associated with precast, prestressed concrete transverse and longitudinal horizontal members. The design is based on the strength of the columns, taking the horizontal loading set up by wind forces and the eccentric vertical loading arising from the cranes. The main columns forming the sides of the frames over the centre bay each weigh 16 tons, and each is located in a hollow base socket 4ft deep. A similar construction has been adopted for the columns to the side bays, the base socket in this instance being 3ft deep. The foundations are designed to take the overturning effects arising from forces acting upon the columns and the bearing. pressures are limited to 2 tons per square foot A prestressed concrete roof beam, having a span of 75ft, forms the frame top at each main column. The beam has a depth of 4ft at the centre, decreasing to 1ft 9in at the ends, a constant flange width of 20in and is prestressed with 100 wires of 0·2in diameter and weighs 15 tons. A similar construction is employed for the roof of the side bays. All the crane gantries, designed as simply supported beams, are in prestressed concrete, those for the central gantry being of 30in by 15in section with 100 wires of 0·2in diameter.

To meet windage effects the lintel over the gable doors is a 34in by 21in hollow prestressed beam weighing 15 tons and carried on the columns framing the door opening, which is 50ft wide and 30ft high. Prestressed concrete bearer beams, supported on brackets on the columns, and longitudinal secondary beams support the timber decking which forms the first floor in the side bays, and is designed to take a superload of 40 lb per square foot. Purlins, eave units, side members and valley gutters, all in prestressed concrete, connect the frames longitudinally, and asbestos cement reinforced troughing sheets form the roof covering. The roof is designed for a superload of 15 lb per square foot. Side cladding is in asbestos cement sheets and "Perspex" glazing down to 9ft above ground level below which are prestressed concrete slabs 3in thick.

Elsewhere in the shipyard Dowsett standard buildings are used in which the basis of the design is to use the weight of the concrete to resist overturning effects. The standard width of the buildings is 28ft and length a minimum of 21ft; the length can be increased in multiples of 7ft. The multi-bay stores building is laid out on ridge centres of 30ft 10in and the walls consist of column units 2ft 2½in wide at 7ft. centres with infilling panels 2ft deep. The roof is erected in units 3ft 6in long, each unit consisting of two panels, and a prestressed concrete tie pin jointed together to form a three-pin arch. Each roof panel is ribbed and reinforced to suit an overall length of about 16ft.

The design and construction of the whole project has been carried out by individual member companies of Dowsett Holdings, Ltd.

Protective Coating for Engineering Drawings

WE have received details of a protective coating for engineering drawings which can be applied to the surface of the paper by hand with a brush, by spray or by roller. It dries and hardens with great rapidity to form a transparent, colourless and flexible film, which adheres to the surface without penetrating the paper. It is then not possible to remove the coating except by means of a specially developed solvent, with which, to allow alterations to the underlying drawing or text, given areas of the coating may be removed. The coating can then be replaced by hand. There is no distortion of the text or drawing, it is stated, colour values are unaffected, and the protective film does not become discoloured with time. Marks made by oil, ink, pencil, or by any other substance with which the drawing may come into contact in normal use may be removed with water or by wiping with a damp cloth without in any way impairing the clearness of the drawing or the texture of the paper, since the coating is entirely proof against water or humidity.

The strength and flexibility of tracing paper is considerably improved by the coating and it withstands the heat and ammonia vapour involved in the photo printing process without embrittlement. The increase in tearing strength is estimated as 250 per cent.

Research and tests which are being carried out show that the coating can also be applied to metal, chromium plate and wood. It could therefore be used to prevent deterioration due to humidity in storage or in transit, to increase the effective life of painted or enamelled surfaces and to enhance their appearance.

Further details of this coating, which is known as "Emulsia," can be obtained from Sheps and Webb, consulting engineers, 15a, Lancaster Grove, London, N.W.3.

V.H.F. Stations for Sound Broadcasting

THE B.B.C. has given some details of the first stage of its scheme for introducing sound broadcasting on very high frequencies (v.h.f.), following the recent announcement by the Postmaster-General that this stage can be put in hand. It will comprise the following nine stations, each carrying the Home, Light and Third Programmes.

	Effective radiated power, kW
Wrotham (Kent)	120
Pontop Pike (near Newcastle)	60
Divis (Northern Ireland)	60
Meldrum (near Aberdeen)	60
Norwich	120
South Devon	60
Sutton Coldfield	120
West Wales	60
Holme Moss	120

As previously stated by the Assistant Postmaster-General, these stations will use frequency modulation. The frequencies to be employed will be within the band 88–95 Mc/s and will be announced later.

The network of stations is intended primarily to be a strong reinforcement of the long-wave and medium-wave services and will make it possible to receive the three programmes free from interference in many areas where reception on medium wavelengths is spoiled by interference and fading, especially after dark during the winter months.

At Wrotham there are already two transmitters, which have been carrying an experimental service since 1950. A third transmitter will be installed and the station will be brought into regular service in May, 1955. The other eight stations will be completed during the following eighteen months; they will be at the same sites as television stations and the same masts will be used as for the television transmissions.

It is expected the radio industry will produce receivers designed for v.h.f. reception and adaptors for use with existing receivers, and they will become available in the various areas in time for the opening of the v.h.f. stations in those areas. These receivers will not be difficult to tune. The receiving aerials needed for v.h.f. will be quite simple, and in many cases an indoor aerial will suffice. Listeners who do not wish to buy v.h.f. receivers or adaptors can continue, as at present, to receive the long-wave and medium-wave transmissions, which will continue for many years side by side with the v.h.f. services.

The building of v.h.f. stations at Pontop Pike and Divis will be a step towards the solution of the long-standing difficulty of the shared wavelength, which makes it necessary for the medium-wave transmitters in North-East England and Northern Ireland to carry the same programme. The nine stations are expected to cover roughly the areas indicated below, but the range cannot yet be stated with certainty. Moreover, there will be local variations in the fringe areas because of the screening effect of hills and large buildings.

Wrotham.—South-East England, including the London area and extending as far west as Basingstoke and Bognor Regis. Towards the north the coverage will link up with that of Sutton Coldfield and Norwich. To the south and east it will extend along the coast of Sussex and Kent except for a small area embracing Deal, Dover, and Folkestone.

Pontop Pike.—The whole of the county of Durham and the North Riding of Yorkshire, most of Northumberland and part of Cumberland.

Divis.—An area including the city of Belfast and extending to the borders of Eire in the south, as far as Cookstown in the west and Coleraine in the north, and as far as the coast on the east.

Meldrum.—All those parts of Morayshire, Banffshire, Aberdeenshire, Kincardineshire and Angus north-east of a line running roughly from Elgin to Montrose.

Norwich.—The whole of East Anglia, joining the service areas of London and Sutton Coldfield in the south and west and extending northwards to Boston and Skegness.

South Devon.—The whole of Devon and Cornwall, excluding possibly, small areas in North-East Devon and the extreme west of Cornwall.

Sutton Coldfield.—An area extending as far as Chester and Gainsborough in the north, Oxford in the south and Welshpool in the west, and linking up with the service area of Norwich in the east. This area includes the Nottingham district, where reception of the Midland Home Service on the medium wavelength is unsatisfactory.

West Wales.—The site of this station has not yet been finally settled, but it is expected to serve an area including the whole of the coast of Cardigan Bay and extending for a few miles inland.

Holme Moss.—The area bounded on the north by a line running roughly from Barrow to Bridlington and on the south by a line from Rhyl to Cleethorpes.

Railway Wheel Cleaning Machine

A MACHINE for cleaning locomotive wheels up to 7ft 3in diameter on the tread has been installed at the Derby works of the London Midland Region of British Railways.

The machine consists of a chamber into which the wheel sets are lowered by a crane; they are then slowly revolved whilst being sprayed with a detergent pumped from a tank positioned under the chamber. In the chamber the wheels rest upon rollers carried on pivoted centres to enable different wheel sizes to be accommodated. One roller in contact with the wheel at each end of a locomotive axle is driven through gearing from an electric motor so that the wheels are revolved slowly while cleaning proceeds.

The chamber is enclosed at the top by steel shutter doors operated by an electric motor, which automatically cuts off as the doors reach the limit of their travel in either the open or closed position. From a series of spray pipes within the chamber jets of liquid under pressure are projected on to all parts of the wheels, axles, crank sweeps, &c. Two centrifugal pumps positioned at the base of the machine draw the detergent from the tank and force it through the jets at a pressure of 25 lb per square inch.

After the pumps have been working for ten minutes a wheel set is thoroughly cleaned, and within a minute or so of the doors being opened again all steam within the chamber is dispersed and the wheels are in a dry condition ready for lifting from the machine.

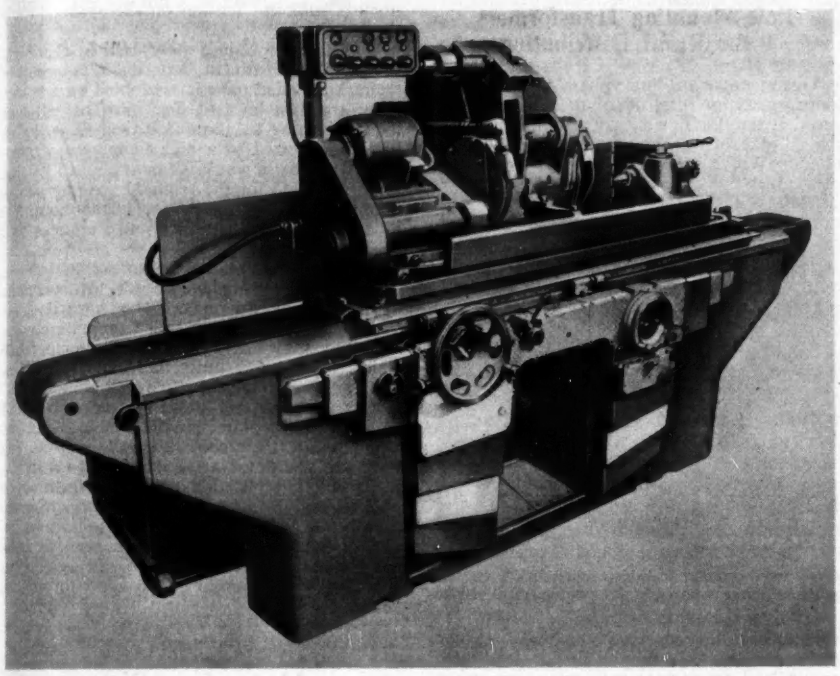
A solution of caustic soda in water is used at present as the cleaning agent, although, we are informed, experiments are being carried out with other detergents. The temperature of the cleaning liquid is raised to 180 deg. Fah. by steam coils fitted to the tank. Arrangements are provided for draining the solution from the machine, and doors are provided for the removal of sludge.

A lifting beam with hooks which can be arranged to engage or disengage their hold on the wheels is provided, making it unnecessary for any careful placing of chain slings or other lifting devices when the wheel sets are in the machine.

Precision Grinding Machines

THREE new machines have been added to the standard range of precision grinding machines made by A. A. Jones and Shipman, Ltd., of Leicester. One of these machines is a universal precision grinder designed to swing work up to 12in diameter by 40in long and is illustrated below.

The wheelhead of this machine is mounted on a double swivel or compound backslide to enable steep tapers to be ground in addition to normal cylindrical and internal work. With this wheelhead mounting, components having a taper greater than that obtainable using the 15 deg. swivelling movement of the table can be satisfactorily handled. The wheelhead unit itself is fitted with a 3 h.p. motor, giving two spindle speeds of 1720 and 2240 r.p.m., and it is mounted on a slide having an adjustment of 5in to cover the extreme range of work size. A compound slide carrying the head can be swivelled up to 90 deg. on each side and facilitates the grinding of acute internal or external tapers. The main feeder slide on which the head assembly is mounted slides on anti-friction balls and rollers. The complete wheelhead assembly is finally mounted on a swivelling base through which it can be swung 90 deg. in a clockwise and 75 deg. in an anti-clockwise direction.



Precision grinding machine with double swivel back slide for steep taper grinding, and hydraulic table traverse with a minimum travel of 0·04in at maximum speed of 180in per minute

The wheel spindle is designed for the mounting of standard wheels of 12in by 1½in by 5in at either or both ends. By this arrangement no changeover of belt drive is required, and wheel positions can easily be changed when dealing with various classes of work. A drop-down-arm internal grinding unit is fitted on top of the head, and is driven by an enclosed endless flat belt from a motor provided with the attachment.

The hydraulic table traverse is designed to give shockless reversal throughout the speed range from 3in to 180in a minute. It is claimed that, regardless of changes of traverse speed, the reversing limits of the table stroke can be maintained to limits of 0·002in. A power traverse stroke of down to 0·02in is obtainable and when this power traverse is disengaged a sensitive hand-operated fine traverse is automatically engaged.

A plunge-cut feed mechanism is arranged for intermittent or continuous cross feed of the wheelhead. A fine feed handwheel arranged inside the main handwheel of this cross feed provides a feed at a ratio of one-tenth that of the main feed, and the dial is notched so that a feed of 0·0001in can be felt without observation. The handwheel is graduated to read divisions of 0·0002in off diameter and a second feed dial is graduated to read actual reduction in diameter supplementary to the normal dial. This second dial shows the amount of material remaining to be ground before reaching a preset zero ; it can be used when setting up new work or when effecting wheel wear compensation.

A six-speed workhead is driven through vee belts on cone pulleys by a ¾ h.p. motor and is arranged for live and dead centre grinding. The lever-operated centre tailstock has adjustable means of spring compression for light or heavy loads. In order to eliminate possibility of vibration the hydraulic pumping assembly is built as a separate unit from the machine and connected to it only by flexible pipes. Coolant is supplied from a large reservoir and, if required, a magnetic or motor-driven mesh filter can be fitted.

Another of the new machines is a precision grinder made in two models for plain cylindrical work or semi-universal operation when fitted with internal grinding equipment, and live and dead centre swivelling workhead. This machine swings work up to 10in diameter and is made with two table lengths to grind work up to 27in or 40in long.

The wheelhead is mounted on anti-friction slides and its spindle is driven through two-step cone pulleys by a 5 h.p. motor. After the machine cycle has been started through the automatic control, the wheelhead is moved in and feed commences at a coarse rate set by a throttle. At a predetermined point set by a dog on the feed handwheel the feed rate is diminished and the remainder of the metal on the component is removed until the feed is halted by a dead stop. A timing arrangement, which can be set to give from 2 to 20 seconds dwell, is brought into effect automatically when the dead stop is reached. At the end of this period the wheelhead retracts and resets and at the same time oscillation of the table and rotation of the workhead also stop ready for the component to be removed and replaced by another workpiece.

The hydraulic table traverse mechanism fitted to this machine is similar to that of the machine first described. A new tailstock which can be fitted on this machine has been designed to overcome the normal difficulties encountered on grinding machines of truing a grinding wheel on the correct generating plane without disturbing the set-up of the work, retracting the wheelhead or resetting the table stops. In this tailstock a sliding member at the rear carries the centre and there is no projection beyond the size of the workpiece being ground so that it is possible to pass the wheel directly from the work across the tailstock to the truing diamond. A truing diamond mounted behind the centre support of the slide is at the same centre height as the grinding wheel and the work centres. The diamond holder has dial indicator adjustment so that the settings of the point can be made to the same radius as the workpiece. The centre slide is lever operated and spring loaded and, if required, means of hydraulic operation can be fitted.

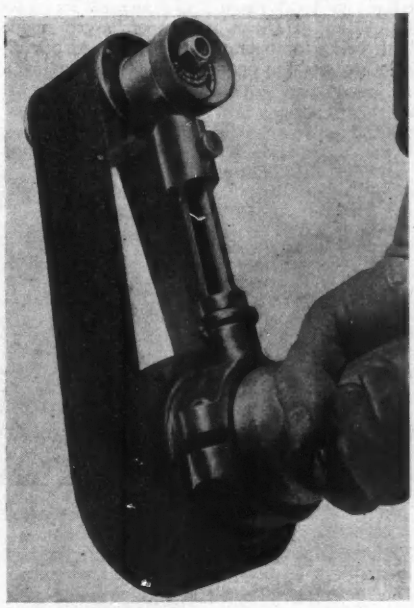
The third new machine introduced by the firm is a 14in by 24in cutter and tool grinder.

Abrasive Belt Attachment for Portable Grinders

AN abrasive belt attachment, which can be fitted to straight spindle portable grinders to increase their capacity and range of application is now being made in this country, under the trade name " Port-a-Belt," by the Carborundum Company, Ltd., Trafford Park, Manchester. This attachment is designed for fitting to most makes of portable pneumatic, electric or flexible shaft driven grinders. It is available in two models for 24in and 30in long belts, each 2in wide, and for respective maximum spindle speeds of 9000 and 6000 r.p.m.

As can be seen from the accompanying illustration, the attachment has a contact or driving pulley which is fitted to the spindle of the machine. The abrasive belt is supported between this pulley and a tension or idler pulley mounted on the end of a light alloy arm designed for attachment to the front of the body casting of the grinder. Driving pulleys are made in two sizes of 4in diameter for the 24in long belts and 6in diameter for the 30in long belts. These pulleys have a light alloy centre on which is moulded an annular rubber ring with deep helical teeth across the face.

The tension pulley is mounted on roller bearings and its spindle is supported by a spring-loaded eccentric assembly in the head of the arm. Flanges on each side of the tension pulley maintain the abrasive belt in correct alignment. When it is required to change a belt the tension pulley is turned in its eccentric mounting against the load of the spring. In this way the pulley centre distance is reduced to slacken the belt a sufficient amount for it to be slipped off and replaced.



Abrasive belt attachment fitted to a portable grinder

When operating a grinder fitted with the attachment the section of the belt supported by the contact pulley can be used for flat or concave work, or the run of the belt between the pulleys for convex surfaces. In the case of convex

surfaces pressure on the work piece draws the belt against the tension imparted by the idler pulley spring and enables it to conform in some measure to the curve of the surface being ground.

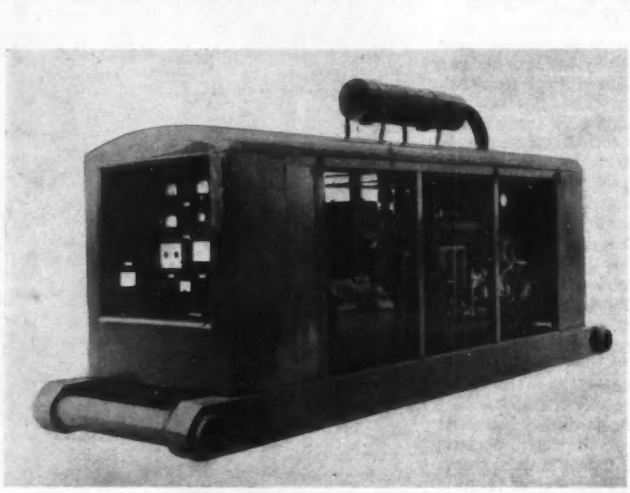
Abrasive belts of from 24 to 320 grit are available for use with these attachments, so that they can be used for grinding a wide selection of metals, for high-speed metal removal, and to give highly finished surfaces.

70kW Diesel Engine Driven Generating Set

DURING a recent visit to Petbow, Ltd., Sandwich, Kent, we were able to make a brief inspection of the works and to see something of the range of products manufactured by the company. The main purpose of the visit was to witness the test runs of the 70kW generating sets which have been built for the Anglo-Iranian Oil Company, Ltd., and which are the first sets powered by Rolls-Royce diesel engines.

In developing this commercial application of Rolls-Royce engines the company considered that where engines of over 100 b.h.p. were required the application would offer a substantial reduction in weight as compared with the slower speed stationary engines in general use. It was felt that any prejudices against the adoption of 1500 r.p.m. working to replace the more usual 1000 r.p.m. would be countered by the known reliability of the engine and so work went forward to establish, early in the year, the "Vulcan" (mobile) and "Merlin" (stationary) generating sets. The construction of the sets generally followed standard Petbow practice and the overall design conformed closely with that used in the "Crusader" and "Vulture" ranges of generating sets driven by the Dorman engine.

At present two basic models are in production, both employing a six-cylinder engine, which is a four-stroke, direct injection, overhead valve, liquid-cooled unit having a cylinder bore of 5½in by 6in stroke. One mark of generator set has an output of 75kW and is powered by a normally aspirated engine which develops 130 b.h.p. at 1500 r.p.m.; the second set gives 100kW and is driven by a supercharged engine, both being for operation at 50 c/s. Also available are sets for operation at 60 c/s running at



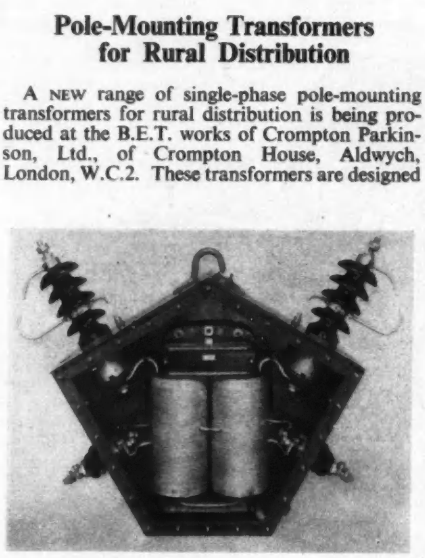
70kW generating set

either 1200 or 1800 r.p.m. It is intended to increase the range to include a four-cylinder unit which will power a 55kW generator set.

In the 70kW sets the Rolls-Royce Mark C6.NFL engine is coupled through a special ring to a flange-mounted Macfarlane "Magnicon" alternator designed to give an output of 87·4kVA at 0·8 power factor (70kW), 440/250V and 50 c/s when driven at 1500 r.p.m. During the demonstration tests three sets were paralleled with more than 50V difference in their outputs, and it was noted that they shared the load equally. In the next test the sets were paralleled out of phase and they settled instantly into synchronism. The completed unit is mounted in a pressed steel main frame containing a sub-frame carried on Metalastik resilient mountings. A radiator and a 24in reverse-flow fan is fitted together with a fuel tank of 87 gallons capacity, and there is a 24V starter motor, for which an eighteen-cell 24V Nife battery is fitted below the resilient-mounted control panel. A protective circuit forms part of the equipment and this automatically shuts the plant down should the oil supply fail or the cooling water exceed a predetermined temperature. The set has an overall length of 14ft by 4ft 4in maximum width by 6ft 1in overall height.

Pole-Mounting Transformers for Rural Distribution

A NEW range of single-phase pole-mounting transformers for rural distribution is being produced at the B.E.T. works of Crompton Parkinson, Ltd., of Crompton House, Aldwych, London, W.C.2. These transformers are designed



Rural pole-mounting transformer of 5kVA capacity with front cover removed to show arrangement of leads

with low-iron-loss characteristics and high over load capacities, to be suitable for low load-factor circuits and to operate with minimum voltage regulation under overload conditions. The range covers 6·6kV and 11kV service voltages and three sizes, 5kVA (illustrated here), 10kVA and 15kVA.

The design is characterised by the pentagonal shape of the tank and the arrangement of the bushings is such that the terminals converge on the transformer windings, thereby eliminating the potential weakness associated with long connections. Access to the windings is readily obtained by removing the front cover, as can be seen from our illustration.

Voltage ratios of 6·6kV/250V or 11kV/250V are available as standard. Normally tappings are provided to give ±5 per cent voltage variation, but other values can be supplied to order. the tappings are brought out to external terminals on the tank, as shown in our illustration, so that the required ratios can be selected without removing the tank covers.

These transformers are arranged for single-bolt fixing and the fittings normally supplied include h.t. and l.t. terminals, "Duplex" arcing horns on the h.t. terminals, a plain breather and an earthing terminal. The optional extra fittings include an oil gauge, a drain pipe and a thermometer pocket.

Supporting Tools for Heat Treatment

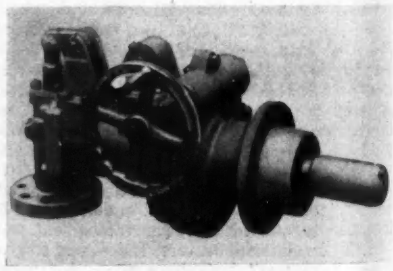
THE heat-treatment of tools such as twist drills usually involves the use of many different holders for suspending the work in salt bath furnaces. With a view to speeding and simplifying the work of loading and unloading tools in this type of holder investigations were carried out in the heat treatment department of Firth-Brown Tools, Ltd., where large quantities of high-speed steel drills and other small tools are constantly being handled. After trying out many different designs of holders a method giving the ease and speed of handling required was found by the use of simple coil springs to suspend the tools from the holders. Drills, or any other tools with tapered shanks, are simply inserted into the end coils with a slight twist and the expansion of the coils imparts sufficient tension on the spring to grip the tool firmly.

With the procedure now used in the Firth-Brown heat treatment department a group of spring suspended tools is assembled on a holder. They are then lowered first into the salt bath for pre-heating to about 850 deg. Cent. before being transferred to a high temperature carbo-neutral salt bath, which is run at about 1300 deg. Cent. and held for the required soaking period. Subsequent removal of the tools from the springs by a slight twist is as quick and simple as their mounting.

The material used for the spring holders was found to be of importance for the successful application of the idea. The normal grade spring steel used at first failed prematurely due to softening by heat flow, since the temperature which the springs must withstand is around 500 deg. Cent. Springs made of "Nimonic 90" were then tried and proved successful as this material not only provided the required strength at the temperatures involved but its high resistance to oxidation and scaling made it suitable for the continued cycle of heating and cooling. We are informed that the life of the springs in use is so far undetermined, for although some have been in daily use for nearly a year, they are still as good as new and would appear to be good for several years' service.

Marine Soot Blower

A NEW soot blower, designed for use with marine boilers, has been introduced recently by Hopkinsons, Ltd., Huddersfield, and is illustrated herewith. This latest product of the company is of retractable pattern and is constructed so as to provide the maximum retraction combined with a minimum overall length. The design has been kept as simple as possible and this factor, together with the robust construction of the blower, has reduced to a minimum the possibility of mechanical trouble arising. In operation the rotation of the handwheel causes the blower nozzle to advance, automatically opens the valve at the correct stage and also gives the nozzle the required arc of blow. There is a built-in automatic valve at the blower inlet, which ensures that the blower parts of the glands are not under pressure until the blower is in actual operation. The blower can be arranged for remote operation by the fitting of an extension spindle.



Marine soot blower

The American Scene

(By Our American Editor)

MORE POWER FOR THE WEST

To many Americans who live in the western sections of the Missouri basin, the most important man in President Eisenhower's cabinet is Mr. Douglas McKay, the Secretary of the Interior. Mr. McKay is responsible for the administration and development of water resources and hydro-electric schemes, and these two items, in many of these areas, represent the difference between prosperity and bankruptcy. They also may represent the difference between victory and defeat for the Republican party in the forthcoming Congressional elections in this area because the Eisenhower administration, in its handling of these resources, has been placed in a serious predicament. The demand for power, both public and private, has been increasing steadily in the Missouri basin since 1946. Last May, a special subcommittee of the Missouri Basin Inter-Agency Committee issued a report estimating that the states in this region would need three times as much power within the next eighteen years as they do now. In March of this year, Mr. Fred G. Aandahl, the Assistant Secretary of the Interior, said that Colorado, Wyoming and Western Nebraska would be faced with a power shortage in 1957 unless some new sources of electrical generation were provided. The power which would become available from government sources, Mr. Aandahl said, had all been over-subscribed by one-third, so that when the dams now under construction by the Federal Government in these areas were completed, there would still be a serious need for more power.

More than half of all the harvested acreage in the Rocky Mountain area and western Nebraska is on irrigated land. Following the end of the last war, a number of irrigation schemes were either completed or begun under the Democratic administration. After the assumption of power by the Republicans, funds were made available to complete most of the projects which were in advanced stages of construction, but work on new facilities was generally limited to the planning and research stages. Most of the major dams in the Missouri basin are multi-purpose units and contain irrigation and flood control facilities as well as power-generating plant. Many of them, in fact, were built primarily for irrigation and flood control, with the power aspect secondary. In the minds of many residents of the western Missouri basin, the irrigation facilities are paramount, and in the past there has been very little debate among local residents over whether it was good or bad for the Federal Government to enter the water and electrical power business. The main concern has been that the dams be built and the water be made available. For example, in recent public hearings before Congressional committees on the possible construction of the important Frying Pan-Arkansas River trans-mountain diversion and east-slope storage scheme in Colorado, the debate centred on whether it was proper to take water from the west slope and move it to the east slope of the Rocky Mountains, not on whether it was proper for the Federal Government to expand its holdings in the hydro-electric power field. In the opinion of some local observers, the Eisenhower administration has spent too much time trying to promulgate a power and irrigation programme based on limited Federal Government intervention. This, in their opinion, has not made as much impression on local residents as would a simple outline of future construction plans. Since taking office last year, Mr. McKay has made several major personnel changes in the Bureau of Reclamation. These generally consisted of asking regional office directors to step down and replacing them with other personnel who were said to be less closely allied to the policies of the previous Democratic administration. In region 6 and region 7 of the Bureau, situated in the Missouri basin, the operational staffs have been reduced and many vacancies have not been filled. This practice may be considered to be in line with the present activities of the Bureau of Reclamation changing from expansion and new construction to completion and mere planning. Mr. McKay himself has recently denied this trend. In a speech in Oregon he said his administration had inherited a " no new starts " order from the Truman administration at the beginning of the Korean war. But, he said, the Department of the Interior is now ready to change this and go ahead with several new schemes. One of the first of these to be proposed is one which, ironically, has stirred up a nation-wide controversy instead of answering the critics who accused the Republican régime of doing nothing. This was the suggestion for a huge dam at Echo Park in the Dinosaur National Monument. Although this project has had considerable support from residents in the Upper Colorado River area, sportsmen and conservationists from all over the United States have protested that it would destroy the scenic aspects of the national park.

However, the *furor* over Echo Park was minor compared to that caused by the plan of the Department of the Interior for marketing power from the main dams now nearing completion on the Missouri River. Briefly, this plan called for offering the hydro-electric power to publicly owned electrical companies, known as " preference customers," first and then selling the remaining power to private utilities on a long-term contract basis. The sale to preference customers first is required by law. But in the past any power left over was offered to private utilities with the provision that it could be withdrawn on short notice if additional preference customers needed it. Soon after this new policy was announced last September, co-operative electrical groups throughout the Missouri basin sounded a call to arms. Many of these groups were led by Republican officers and had large groups of Republicans as members. But this did not prevent them from charging that the Eisenhower administration was attempting to scuttle the rural electrical " co-ops " in favour of the private electrical power groups. By December the outcry had reached a very loud and bitter pitch, and Mr. McKay issued several statements denying that the co-operatives would be injured by the ruling. By mid-winter, it was obvious that the initial plan was outdated, since requests for power from the preference customers were greater than the amount of public power available. But this fact did not quiet the critics of Mr. McKay. Several of the Missouri basin co-operative associations have continued to demand a complete revocation of the new plan and a return to the old one. In an effort to offset these demands, members of Mr. McKay's staff have travelled through several Missouri basin states, meeting with co-operative groups and attempting to assure them that their needs would be met. To what extent these efforts have allayed the fears of electrical co-operative members cannot be determined immediately. The pressure on Mr. McKay and his associates has undoubtedly eased. But many Republican officials have privately expressed the fear that they may have been left vulnerable by this situation. In Colorado, Wyoming and Montana and, to a lesser extent, in the Dakotas and Nebraska, the handling of power and irrigation facilities has given anti-administration Republicans and Democratic party leaders opportunities for attack on Republicans seeking re-election. It is certain that these opportunities will be used to the fullest advantage before the elections this autumn.

" Glow-Plug " Starting System for Diesel Engine Tractors

For use with the Caterpillar " D4 " tracked tractor an all-weather direct electric starting system incorporating " glow plugs " has recently been developed jointly by the Caterpillar Tractor Company, Peoria, Illinois, and The General Electric Company of Schenectady. This starting system is operated from 24V electric batteries installed under the hood in the space formerly used to house the gasoline starting engine. The glow plug is essentially a heating element about the size of an ordinary lead pencil, part of which projects into the pre-combustion chamber of the diesel engine. Briefly, the glow plug consists of a fine resistance wire wound spirally inside a tubular sheath and insulated from it by magnesium oxide. The tube is run through a die to reduce its diameter and to compact the magnesium oxide around the wire.

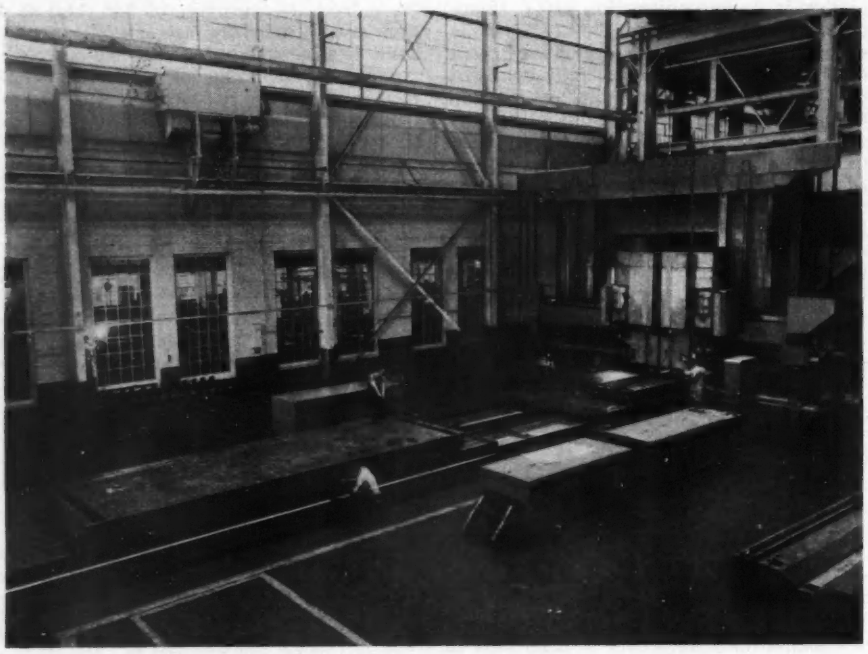
When the plugs are connected to the battery by operating a push button the heat generated in the wire is rapidly transmitted to the sheath, which, it is stated, attains a temperature of 1800 deg. Fah. within thirty seconds. Accordingly, the air in the precombustion chamber is warmed sufficiently to assist fuel ignition when the engine is cranked.

Tests have been carried out by the maker after exposing a " D4 " tractor for a week-end during the cold weather, without any protective housing. These tests indicated that the glow plugs should be preheated (before cranking) for periods up to four minutes, depending on the temperature. With such preheating an average cranking time of 1·2 seconds was obtained on those mornings when the temperature was below freezing.

Experimental Electrical Generating System for Farm Tractors.—An experimental electrical generating system, known as " Electrall," mounted on the International Harvester Company's " Farmall " tractor, has been demonstrated at the company's experimental farm near Hinsdale, Illinois. The equipment consists of a small General Electric generator which is mounted on the offside of the tractor and is driven by vee-belts from the tractor engine. There are three outlets, by flexible cable, from the generator : one provides 220V, three-phase, 60 c/s alternating current, primarily for driving electric motors on trailing or tractor-mounted farm machines ; the second outlet provides a 120V single-phase supply, suitable for electric tools or portable lamps ; the third provides power for 220V single-phase circuits.

Large Adjustable-Rail Milling Machine

AS part of its current expansion programme the Ingersoll Milling Machine Company has installed at its Rockford Works in Illinois a very large adjustable-rail milling machine, which is shown in the first photograph we reproduce herewith. The machine is 14ft wide between housings and will accommodate work-pieces up to 12ft high under the rail. The machine bed is 123ft long and the table is 62ft long. Weighing 500 tons, the machine rests on a reinforced concrete foundation, which is 133ft long by 42ft wide and up to 11ft thick. Approximately 870 cubic yards of concrete and 30 tons of steel reinforcing rods were used in the foundation.



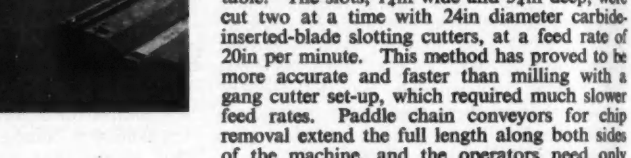
Ingersoll adjustable-rail milling machine

An interesting aspect of the design of the milling machine is the amount of power available for cutting metal. Three of the four milling heads on the machine—two vertical heads and a right-hand horizontal head—are each equipped with a 150 h.p. electric motor. The left-hand horizontal head is powered by a 250 h.p. motor, which can be overloaded up to 400 h.p. for periods of up to three minutes. An unusual feature of the milling machine is the construction of the table in two sections, one 27ft long and the other 35ft long. Both sections can be used together as a unit, or either one can be "parked" at one end of the machine. When the sections are separated, work can be set up on one while parts on the other one are being milled, thus minimising the "down" time on the machine. The table sections can be separated in about two minutes by means of air-operated spanners. Power shank rods are provided on all heads to facilitate quick and easy cutter changes. Practically all functions of the machine are controlled by push buttons that are mounted on a convenient portable pendant. Even the spindle-speed gears in the vertical heads are rapidly changed by electrical means, and no hand-levers are provided. Separate electronic controls are furnished to control the feeds of the table, the horizontal and vertical heads and the cross rail. The rail clamps, too, are power-operated and are electrically controlled.

Although the primary reasons for building and installing the machine were to permit the economical machining of large parts and to increase production, it also was designed for research and experimental work. With the aid of the machine, more efficient machining methods and better cutting tools are now being developed. New ideas resulting from the operation of the machine are being passed on to customers, enabling them to increase production with existing equipment, and making it easier for them to justify investment in larger and more powerful milling machines. A set-up for the rough milling of the top of a large cast-iron table for a machine is shown in the second illustration. In this operation, up to 9/16in of stock is removed with 13in wide cuts at feed rates of about 60in per minute. Prior to the building of this large adjustable-rail milling machine, the usual feed rate for rough milling similar cast iron table tops was in the neighbourhood of 20in per minute. The tools shown in this illustration are Ingersoll heavy-duty milling cutters equipped with carbide-tipped blades.

It has been found that considerable economies are possible when the machine is equipped with right-angle attachments. The use of such attachments permits milling both ends of large castings after milling the sides and top in the conventional manner, without the need for resetting the work. The accuracy of the work-piece can be held to closer tolerances when all cuts are thus taken in one setting of the work. An example of the accuracy maintained was the production of a 74ft long bed for a die-block milling machine. The bed was milled in three sections. First, it was machined lengthwise in the conventional manner and then across the ends with a right-angle attachment. When assembled, without any hand scraping, it was found to be within 0·003in of being straight over its entire 74ft length. In the set-up shown in the last illustration, two right-angle attachments are being employed to slot a machine table. The slots, 1¼in wide and 3¼in deep, were cut two at a time with 24in diameter carbide-inserted-blade slotting cutters, at a feed rate of 20in per minute. This method has proved to be more accurate and faster than milling with a gang cutter set-up, which required much slower feed rates. Paddle chain conveyors for chip removal extend the full length along both sides of the machine, and the operators need only brush the chips from the table. The chips carried on these conveyors slide down chutes and are carried in tube conveyors to a centrally situated disposal area outside the assembly department. The milling machine has been installed in the new erecting shop of the works, which has a 42ft high clearance in the bays and is served by 40-ton cranes having 96ft spans. These facilities permit the manufacture of the extraordinarily large and heavy machines which are used for milling diesel engines, turbine shells and rotors, die blocks for producing aircraft parts, rolling mill and press housings, and other large castings.

Rough milling top of a cast iron machine table



Slotting a machine table with right-angle attachments

Industrial and Labour Notes

Changes in Rates of Wages

A note in the *Ministry of Labour Gazette* states that in the industries covered by the department's statistics, the changes in the rates of wages reported to have come into operation in the United Kingdom during June resulted in an aggregate increase estimated at approximately £118,000 in the weekly full-time wages of about 667,000 workpeople, and in a decrease of about £300 for 13,000 workpeople.

The principal increases affected workpeople employed in the iron and steel industry, furniture manufacture, and boot and shoe manufacture. The decrease, which operated under sliding scale arrangements based on the index of retail prices, affected workers in the iron and steel industry in a few districts, and iron ore miners and limestone quarrymen in Cumberland.

In the iron and steel industry in most districts there were small increases payable under sliding scale arrangements based on the index of retail prices.

Industrial Disputes

There were 150 stoppages of work arising from industrial disputes connected with terms of employment or conditions of labour in the United Kingdom which were reported to the Ministry of Labour and National Service during June. Of these disputes, 121, involving 13,600 workers, were in the coal-mining industry, and seven, involving 2500 workers, were in the vehicle industry.

During the first six months of the year there began some 1041 stoppages involving 202,300 workpeople, and these stoppages involved a loss of 689,000 working days. A majority of the stoppages were concerned with the coal-mining industry, where 779 disputes involving 118,000 workers lost 279,000 working days. In the engineering and the shipbuilding and ship repairing industries fifty-two disputes involving 8700 workers lost 45,000 working days.

Duty-Free Imports of Machinery

The president of the Board of Trade, Mr. Peter Thorneycroft, announced recently in the House of Commons that the Government had accepted the Wilson-Smith committee report on duty-free entry of machinery as a whole, and with only one reservation. It had been decided to put the committee's recommendations into effect as from August 4th. He pointed out that the basic recommendation was that some discretionary system to permit the duty-free entry of machinery in suitable cases was in the national interest. The committee did not, however, recommend the continuance of so general and widespread a scheme as that which obtained before duty-free licensing was suspended in 1952. This recommendation had been accepted by the Government and it proposed to resume duty-free licensing of machinery under section 10 of the Finance Act.

The report recommended four main changes in previous practice. The first was that the applications eligible for consideration should be confined to consignments of similar or closely associated machines where the value of the machinery otherwise eligible for a duty-free licence required by the individual user was not less than £2000. The Government accepted that limit as recommended.

Secondly, as regards similarity of machines, the report recommended that the suitability of machines for the particular work for which they were required should be taken into account in cases where the applicant could establish that the machine was to be used to a very substantial extent for this special purpose, but that duty-free entry should not be allowed unless the imported machine had a definite and marked technical superiority for that purpose. The Government proposed to adopt this recommendation.

The report recommended, thirdly, that the responsible department should set up a consultative committee containing representatives of industry whose functions would be to keep under review the broad policy followed by the administering departments and to represent industry's views to them. The president said he proposed to appoint a consultative committee as soon as possible.

One recommendation on which the Government must for the present reserve its decision was for the extension of duty-free entry provisions to cover plant. Legislation would be necessary before this could be put into effect, and the Minister proposed to explore this matter further with the consultative committee as soon as it was appointed.

Increase in Northern Ireland's Trade

According to statistics issued by the Northern Ireland Ministry of Commerce, the value of Northern Ireland's total trade in 1953 amounted to the record figure of £495,670,000, an increase of almost £39,000,000 compared with the figure for the previous twelve months. Exports at £237,048,000 were also the highest ever and showed an increase of more than £21,000,000 compared with the previous year. Imports at £258,622,000 showed an increase of more than £17,000,000 compared with the 1952 figure. The adverse balance at £21,574,000 was about £4,000,000 less than in 1952 and the lowest since 1948.

The figures of the tonnage of goods imported and exported through the principal ports of Northern Ireland showed that there was an increase in the overall volume of trade. Imports amounted to 5,662,000 tons and exports to 1,074,000 tons.

Engineering Wages

In the course of his presidential address at the annual meeting of the Confederation of Shipbuilding and Engineering Unions, on Tuesday last, Mr. H. G. Brotherton drew attention to the generally healthy state of the engineering industry. He said that in the light of the facts on production and profits, it was clear that employers could afford to reach agreement with the unions for improvements in the conditions of the workpeople of the industry. An immediate problem before the Confederation was to determine whether there should be a claim and, if so, what form it should take. The question of a revised wages structure was one that had been before the industry for a number of years. It carried with it the recommendation of an earlier Court of Inquiry, and no one who knew the industry could deny the need for a new structure to overcome the anomalies which existed.

Mr. Brotherton went on to say that any claim for a new structure, however, would obviously have to take into account present-day conditions. If it was proposed to establish new minimum rates for craftsmen, and bring simplification and improvement to other groups, it was essential that it should be done in the light of existing circumstances.

It should not be overlooked, for example, that, despite the increases conceded earlier this year, the minimum rates in engineering, particularly for skilled men, still compared unfavourably with many other industries. Whilst employers pointed to the higher average earnings of some of the workers in the industry, it must not be forgotten that earnings included payments for overtime and for special effort on piecework, he said. There were still many workers on or near the minimum rates, and, as the Court of Inquiry rightly emphasised, rates rather than earnings were the best measuring rod.

Industrial Accidents in the United States

An abstract in the *Ministry of Labour Gazette* states that, according to preliminary estimates of the United States Department of Labour, the total number of disabling work injuries in the United States during 1953 was about 2,034,000, compared with the final estimate of 2,040,000 for 1952. As there was a somewhat higher level of employment during most of 1953 than in 1952, the fact that the total number of injuries did not rise is regarded as a favourable indication of achievement in efforts to bring about greater safety in employment.

The definition disabling work injuries includes, in addition to injuries resulting in death or any degree of permanent disablement, injuries resulting in temporary incapacity for work lasting for at least the length of one working day after the day of injury. Work injuries to employees, self-employed persons, and unpaid family workers in agriculture and all other industries, except domestic service, are included. The term "injury" includes occupational disease.

The total for 1953 included about 15,000 deaths and 84,000 injuries resulting in a permanent disability. The number of persons permanently disabled included about 1500 who were completely incapacitated for any further gainful employment. In the remaining 1,935,000 cases the injured workers recovered without any permanent ill effects.

Disabling work injuries are estimated to have caused the loss in 1953 of approximately 41,000,000 man-days, or the equivalent of a loss from the labour force of 137,000 full-time workers for the entire year. Making allowance for loss of future production resulting from the deaths and permanent physical disablements, the total economic time loss amounted to about 206 million man-days, or one year's full-time employment for about 687,000 workers.

Railway Wages Negotiations

On Friday last, August 6th, the railway unions rejected final proposals of the British Transport Commission for the revision of the railway wage structure. Under the proposals made by the Commission the revised wage structure would have cost some £6,000,000 a year. The proposals put forward by the unions would, they estimate, cost about £12,000,000 a year, whilst the Commission states that they would cost some £18,000,000 a year. A further meeting is being held to-day between the unions and the Commission, and it is hoped to find some mutually acceptable way out of the present deadlock.

Employment and Unemployment

The report of the Ministry of Labour and National Service on the employment situation in this country at the end of June shows that the working population increased by 36,000 to a total of 23,531,000, of whom 15,921,000 were men and 7,610,000 were women. Of the total of 22,466,000 people in civil employment at the end of the month, 14,954,000 were men and 7,512,000 were women.

The analysis of civil employment for June shows that in the basic industries the number of people employed had increased to 4,018,000, as compared with 4,014,000 the previous month, but showed a definite decline when compared with the total of 4,067,000 at the same time a year ago. In the manufacturing industries as a whole employment rose by 10,000 to a total of 9,009,000 during the month. This industrial group showed an addition of 5000 in the engineering, metal goods and precision instrument trades, bringing the total to 2,633,000 persons. In the building and contracting industry the number of people employed decreased by 2000 to 1,423,000; in the professional, financial and miscellaneous categories the number employed increased from 3,983,000 to 4,002,000; this seasonal increase is mainly attributed to the requirements of hotels and catering establishments.

The number of people unemployed at July 12th last was 220,100, or 1·0 per cent of the estimated total number of employees, and this number included 11,300 persons who had temporarily stopped work. This total of unemployed persons was the lowest since September, 1951.

Notes and Memoranda

Rail and Road

ROAD TRANSPORT GUIDE.—The names, addresses and telephone numbers of those who operate long-distance road transport services are contained in the July-December "A.B.C. Goods Transport Guide." Details of parcels services; names, addresses and telephone numbers of clearing houses; machinery carriers; bulk liquid carriers; British Road Services and railway offices; warehouse keepers; London public wharfingers; and air charter companies are also given. The guide is published by Iliffe and Sons, Ltd.

BRITISH RAILWAYS' WINTER TIMETABLES.—Under the British Railways' winter timetables, which will come into operation on Monday, September 20th, a large number of summer "accelerations" will be continued throughout the winter. There will be forty-seven trains making start-to-stop runs at 60 m.p.h. or more, compared with forty-six in the present summer service and twenty-seven last winter. Notable new accelerations will be those on the Euston-Glasgow route of the "Mid-Day Scot" (present time cut by forty-five minutes north-bound and twenty minutes south-bound) and the "Royal Scot" (winter schedule cut by thirty minutes north-bound and fifteen minutes south-bound). During the period of the winter timetable it is also hoped to introduce lightweight diesel trains in Lincolnshire and West Cumberland and on the Watford Junction and St. Albans branch.

Air and Water

SALVAGE OF FRENCH DESTROYER.—Last week the Admiralty Salvage Organisation completed the first of the final stages in the salvaging of the French destroyer "Maille Breze," which was sunk in the Clyde during the second world war. The ship, which weighed about 3500 tons, including the mud inside her, was lifted bodily, and cradled beneath five lifting vessels, then moved a short distance to where she now rests on a hard bottom. Further lifts will take place with a view to beaching the ship on the Ardmore Bank.

AIR TRANSPORT ADVISORY COUNCIL.—The Lord Chancellor has reappointed Lord Terrington, as Chairman of the Air Transport Advisory Council for a further two years. The following members of the Council have also been reappointed for a further two years by the Minister of Transport and Civil Aviation:—Mr. Gerard d'Erlanger, Sir John Ure Primrose, and Mr. J. J. Taylor. Mr. d'Erlanger, who has also been appointed deputy chairman in succession to Lord Runciman, is relinquishing his directorship of the British Maritime Trust.

Miscellanea

STORAGE OF CALCIUM CARBIDE.—The second (revised) edition of the booklet entitled "The Storage of Calcium Carbide" has been published by the British Acetylene Association. The booklet is issued for the guidance of licensing authorities and all concerned with the storage and handling of calcium carbide, and costs 4s. 6d.

BAILEY BRIDGING BULLETINS.—Thomas Storey (Engineers), Ltd., has produced two bulletins describing recent Bailey bridging projects which the firm has undertaken, namely, the single-single bridge over the railway at Birchington, Kent, and the 240ft triple-single flush deck bridge giving access to the Seyham dam in Southern Turkey.

ORGANISATION OF APPLIED RESEARCH.—The Organisation for European Economic Co-operation, 2, Rue André Pascal, Paris (16e), has published, in three volumes, a report entitled "The Organisation of Applied Research in Europe, the United States and Canada." The report is the result of visits to about eighty research establishments in Europe and a similar number in North America.

SMALL WORM REDUCER.—We are informed that David Brown Gears (London), Ltd., of Stonebridge Park Works, London, N.W.10, has increased its range of "Radicon" worm reducers to include a unit capable of transmitting drives from 0·20 h.p. to 3·55 h.p. This reducer is fitted with detachable feet and can be arranged to operate in any one of twenty-four mounting positions. It is available with ratios ranging from 5·25 : 1 to 60 : 1.

TRADE COMMISSIONER APPOINTMENTS.—It is announced by the Board of Trade that Mr. A. R. Starck, at present United Kingdom Trade Commissioner in the Eastern Caribbean with headquarters in Trinidad, has been appointed United Kingdom Trade Commissioner in Melbourne in succession to Mr. A. W. Burton, who retires on November 30th next. Mr. D. Broad, at present serving as a United Kingdom Trade Commissioner in New Zealand, will succeed Mr. Starck in Trinidad in October.

SPECIAL EXHIBITION OF HISTORIC ASTRONOMICAL BOOKS.—From August 18th until the end of December, the Science Museum will be showing some of the most important books on astronomy which were published between the fifteenth and the middle of the nineteenth centuries. Such books as Newton's "Principia" and "De Revolutionibus Orbis," by Copernicus, as well as the works of such famous astronomers as Tycho Brahe, Kepler, Halley and Herschel are to be shown. The exhibition will include photographs of many of the illustrations in the books. The Royal Astronomical Society has lent a number of books from its library to supplement the Science Museum's own collection. Hours of opening are: weekdays, 10 a.m. to 6 p.m.; Sundays, 2.30 p.m. to 6 p.m. Admission is free.

THE MODEL ENGINEER EXHIBITION.—On Wednesday next, August 18th, "The Model Engineer" exhibition will be opened at the New Horticultural Hall, Westminster, and preliminary information received from the organisers indicates that this year's exhibits will be as varied and to the same high standards of craftsmanship as in previous years. Nearly thirty entries have been received for the Students' Cup competition introduced this year, as well as the usual large number of entries for the other model competitions. The exhibition will remain open until Saturday, August 28th.

LECTURES ON PARTICLE SIZES IN FINE POWDERS.—A course of lectures, demonstrations and practical instruction on the measurement of the particle size characteristics of fine powders will be given at King's College, University of London, during the week commencing September 27, 1954, by Dr. H. E. Rose. The course will cover the more common techniques for the determination of the size characteristics of powdered materials in the sub-sieve range, the principles and theory of the simpler methods of analysis, the relevant calculations, and a discussion of the limitations and fields of application of the various methods.

R. B. BENNETT EMPIRE PRIZE.—The 1954 R. B. Bennett Empire Prize of 100 Guineas has been awarded by the Royal Society of Arts to Dr. Chalmers Jack Mackenzie. Dr. Mackenzie began his professional career as an engineer in 1910 and after war service, he was appointed professor of civil engineering in the University of Saskatchewan. In 1935, he became a member of the Advisory Council of the National Research Council of Canada, and was appointed its president in 1944. In 1948 he was made president of the Atomic Energy Control Board, and resigned this position in 1952 to become president of Atomic Energy of Canada, Ltd., a Crown company, from which he retired in October last year. The R. B. Bennett Empire Prize is awarded every three years "for the most outstanding contribution from the Dominions, India, Burma and the Colonies, to the promotion of the arts, agriculture, industries and commerce of the overseas empire during each intervening period."

TECHNICAL MEETINGS IN PARIS.—We are informed that the third Salon de la Chimie et des Matières Plastiques, which will be held from December 3rd to 12th at the Porte de Versailles, Paris, will also be the occasion for a number of international conventions. The most recent developments in the production of basic chemical raw materials, their processes of manufacture and methods of use, will be the general subject of a series of lectures and discussions. These meetings will be divided into the following groups:—December 3rd, new vacuum techniques; December 4th, perfumery and cosmetics; December 6th, chromatography and ion exchange; December 7th, applications of microscopy in chemistry; December 8th, antifouling paints; December 9th, electronic techniques in the service of chemistry; December 10th, control and regulation systems in sugar refineries, corrosion; December 11th, recent developments in plastics, corrosion. Detailed programme may be obtained from the Secrétariat du Comité d'organisation, 28, rue Saint-Dominique, Paris, 7.

NINTH ELECTRONICS COURSE AT HARWELL.—The ninth electronics course of the Atomic Energy Research Establishment is to be held at the Isotope School, Harwell, from Monday, November 1, to Friday, November 5, 1954. Attendance at the course is limited to twelve students. Applications to attend the course are invited from physicists and electronic engineers holding a degree or equivalent qualification. The course covers the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry, and in work with radio-isotopes. The syllabus will include lectures and practical work concerned with counters, d.c. and pulse amplifiers, coincidence units, scalers and ratemeters, and the lecturers and demonstrators will be specialists from the Atomic Energy Research Establishment. The Isotope School is outside the security fence and the subjects will be non-secret. The fee for the course is twelve guineas, and living accommodation can be arranged locally at a charge of five guineas approximately. Application forms (to be returned by October 15th) can be obtained from the Electronics Division, A.E.R.E., Harwell, Didcot, Berks.

HISTORIC MODEL LOCOMOTIVE.—A model of the "Rocket" which has recently come into the possession of Babcock and Wilcox, Ltd., is noteworthy on account of its historic associations and that it was built less than ten years after its famous prototype was still in steam. Babcock and Wilcox, Ltd., states that, according to available records, this model was one of two built by a workman in the works of George Stephenson and Son, soon after the death of George Stephenson in 1848, to commemorate one of his most outstanding achievements. One model, it is said, was presented to Robert Stephenson, son of George, and of that there is no trace. The other model was presented to George Robert Stephenson, nephew of George and a director of the firm, and it descended through his son, Thomas St. Lawrence Stephenson, and then to a son of his wife by a previous marriage, Mr. William Alexander Mitchell. It has been acquired by Babcock and Wilcox, Ltd., on account of its interesting association with the pioneer days of steam, and will join the collection of models in the firm's private exhibition hall and cinema in Salisbury Square House. The scale of the model is approximately one-fifteenth full size, the gauge being just under 4in and the length 15in between buffer beam and rear of footplate, with an overall height of 12in to the chimney top. It stands on a miniature track under a glass dome 20in high. Made principally of brass, with a copper boiler, the model appears to be complete in detail and is obviously intended to steam.

SLOTTED ANGLES.—A leaflet recently issued by Sommerfields, Ltd., Wellington, Shropshire, illustrates some of the many applications and forms of construction possible with the firm's "Slangle" slotted angles. This structural material consists of steel angle, 3in by 1½in by 0·080in thick, and it is supplied in 12ft lengths. The slots are pierced longitudinally along its narrow side and diagonally on the wide side. Each diagonal slot terminates in a short longitudinal slot at each end, and when an assembly is being erected the connecting bolts can be slipped into the short longitudinal section of the slot before tightening to "lock" the structure against slipping should a bolt become loose. The diagonal arrangement of the slots also imparts rigidity, because joints do not entirely depend upon straight slots in which an insufficiently tightened bolt can slip. In addition to special hinges and shelving panels for use with these slotted angles the firm also supplies a special cropping tool for cutting at right angles when short lengths are required. The angles are rustproofed by a phosphating process and stove enamelled with an olive green finish.

NATIONAL SERVICE AND INDUSTRY.—The British Association for Commercial and Industrial Education states that its London and Home Counties group is organising a one-day conference to discuss the impact of national service on industry. The conference is to be held in the Fyvie Hall of the Polytechnic, Regent Street, London, W.1, on October 5th, beginning at 9.30 a.m. The principal objects are to give the three Services an opportunity to explain methods of selection, training and education used in dealing with national servicemen; to obtain representative opinions from those concerned in industry, commerce and education on how national service could be made more valuable for a man's future civilian life, and to discuss what action can be taken by employers, educationists and others to help young men to derive the greatest benefit from their period of service. Non-members of B.A.C.I.E. will be welcome at the conference. A charge of 10s. is to be made and applications should be sent, not later than September 21st, to the conference secretary, Mr. B. M. MacGinty, c/o, The Metal Box Company, Ltd., Portland Place, London, W.1.

Personal and Business

MR. G. W. BONE has been appointed a director of Ruston and Hornsby, Ltd.

CROMPTON PARKINSON, Ltd., announces that Mr. R. R. Kenderdine has been appointed an executive director of the company.

MR. G. E. HUGHES-JONES has been appointed manager of the Newcastle office of the Brush Electrical Engineering Company, Ltd.

MR. JOSEPH CHAMBERLAIN, chief engineer, and Mr. Harry Alexander Blackwell, manager of the evaporator division, have been appointed directors of Aiton and Co., Ltd.

THE APPLEBY-FRODINGHAM STEEL COMPANY, Scunthorpe, announces that Mr. Albert Jackson, general works manager, has been appointed a director of the company.

MR. BRIAN GRIMSTON, who has been associated with Grimston Astor, Ltd., since the company was formed in 1946, as managing director and chairman, is retiring from the board.

THOMAS STOREY (ENGINEERS), Ltd., of Victoria Street, London, has been appointed sole agents in the British Isles for Lorrain Equipment, the products of the Thew Shovel Company of Lorraine, Ohio, U.S.A.

MR. C. E. SLADE has left the service of Philips Electrical, Ltd., and is starting a practice as a consulting engineer specialising in resistance welding. His address is 11, Trowlock Avenue, Teddington, Middlesex.

GENERAL REFRACTORIES, Ltd., has opened an office at the White House, 111, New Street, Birmingham, 2. The company also announces that Mr. Geoffrey G. Abraham has been appointed its representative in the Middlesbrough area.

MR. F. G. BURLAND, who since 1939 has been in charge of London Transport's permanent way design section, is retiring this month. During the past thirty years Mr. Burland has been responsible for the design of most of the major permanent way track work on London Transport's railways.

ACME CONVEYORS, Ltd., has taken additional premises to house its technical and development staff. Its new offices are at 22, Hans Road, S.W.7. Mr. George Taylor has joined the company as technical manager to supervise the work there. Mr. John Olivere has also joined the company as sales manager.

THE NORTH BRITISH LOCOMOTIVE COMPANY states that it has signed an agreement with Maschinenfabrik Augsburg-Nürnberg A.G., Augsburg, designers and builders of the M.A.N. diesel engine. The agreement will enable North British to manufacture diesel engines for rail traction and other purposes from approximately 100 b.h.p. to 2000 b.h.p.

BLAW KNOX, Ltd., of 94, Brompton Road, London, S.W.3, announces that it has concluded an arrangement with the Blaw Knox Company of the United States for the manufacture in this country of "Buflovak" equipment for evaporating, drying, solvent recovery, and other processes. The new chemical plants department of the company will be under the management of Mr. Guy N. Harcourt, who was vice-president of the "Buflovak" equipment division of the American company.

British Patent Specifications

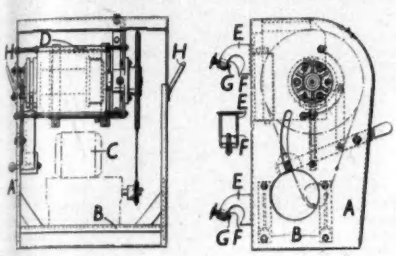
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

BUILDING AND CIVIL ENGINEERING

711,780. July 15, 1950.—A PORTABLE HOIST, Service Engines (Newcastle), Ltd., and Robert Frame, both of 93, Percy Street, Newcastle upon Tyne, 1.

The object of the invention is to provide an improved portable hoist which may be transported by hand from point to point in a building scaffolding and be quickly attached or detached without the use of tools. Referring to the drawing, *A* is a box-like frame having in its lower portion bearers *B* on which is mounted a power unit *C* and rope drum assembly *D* driven by it. The casing has secured at four points on its rear face twin downwardly directed hook-like brackets *E*, each pair of hooks being separated by a

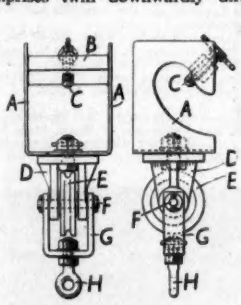


No. 711,780

transverse block *F* at the lower extremities of the outer portion of the hook, for the reception of a locking screw *G*. The hook opening is of the same curvature as the horizontal scaffold tubes, the centre of the curvature being above the axes of the locking screws *G*. The upper pair of twin brackets is spaced from the lower pair by a distance corresponding to the spacing of two adjacent horizontal scaffolding tubes. A lifting handle *H* is secured to the upper portion of each of the end members. In use, two operators transport it by means of the handles *H* to the required location and with the locking screws screwed back the brackets *E* are dropped over two horizontal scaffold tubes. The locking screws are then screwed up against the scaffold tubes, and the hoist is held securely. Two or more pulley blocks are then placed into position over horizontal scaffold tubes higher up the scaffolding at the desired points. The hoist shown in the drawing is also shown in Specification No. 711,891.—*July* 14, 1954.

711,890. July 15, 1950.—A SCAFFOLDING BRACKET, Service Engines (Newcastle), Ltd., and Robert Frame, both of 93, Percy Street, Newcastle on Tyne, 1.

The invention consists in an improved bracket for use on the horizontal members of structures such as building scaffolding and is divided out of the co-pending specification No. 711,780, the object being to provide a pulley block which may be attached to scaffolding so that the pulley is self-aligning with the hoist cable. Referring to the drawing, the pulley block comprises twin downwardly directed hook

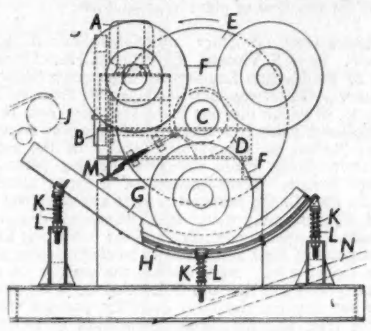


No. 711,890

brackets *A*, each pair of hooks being separated by a transverse block *B* at the upper portion, for the reception of a locking screw *C* which has at its outer end a head and short wings or tommy bars for turning by hand. The hook opening is of the same curvature as the scaffold tubes. To the hook is secured a twin pulley bracket *D*, between the arms of which is mounted a pulley *E* on a spindle *F*, whose ends are extended to receive a hanger *G* carrying an eye-bolt *H* for hooking in the end of the cable. In an alternative form, the hook opening may be tapered so that the sides of the hook engage with a wedging action over the scaffold tubing so that locking is not necessary.—*July* 14, 1954.

712,010. June 30, 1952.—MACHINE FOR SEPARATING PEBBLES AND STONES FROM CLAY, The Butterley Company, Ltd., Ripley, Derbyshire; and Frank Catchpole, of the company's address.

The invention has for its object to provide a machine for separating pebbles, stones and the like from clay, which is simple in construction and efficient in action



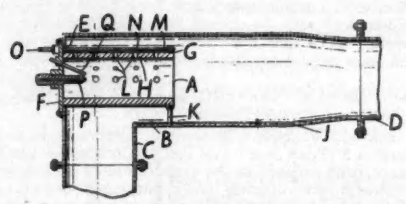
No. 712,010

The drawing shows one set of pneumatic-tyred wheels at one side of the machine, but a duplex arrangement can incorporate two sets of such wheels at opposite sides of the machine driven by a common motor. A motor *A* drives through belts *B* a shaft which through crown and bevel or other suitable gearing drives a shaft in a housing *C*. The shaft has a fixed cam disc *D* around it and a plate *E* secured on it. Upon the plate are mounted the axles upon which the pneumatically tyred wheels *F* freely revolve. At a part of each revolution of the plate each wheel enters a trough *G* having a grid base *H*. Clay is fed into the trough by the conveyor *J*. The trough is yieldingly supported by cross members resting on springs *K* around guide rods *L*. The trough and grid yields, as do also the pneumatic tyres, so that a very strong squeezing action is exerted on the clay between them, which results in the clay passing through the grid, whilst the stones in the clay are retained on the grid. A scraper *M* shaped at its outer end to be a free fit in the trough is carried by the plate *E*. The scraper at its inner end is spring pressed upon the fixed cam *D*, with the result that as the plate revolves, the scraper is, once in each revolution of the plate, caused to sweep along the trough and discharge from off the grid any stones on it. These can be received by a suitable discharge chute, not shown. The clay which is squeezed through the grid may be received by a conveyor *N*, which delivers it to a grinding pan.—*July* 14, 1954.

INTERNAL COMBUSTION ENGINES

711,773. March 17, 1950.—WASTE HEAT PLANTS, The Clarkson Thimble Tube Boiler Company, Ltd., 15, Fetter Lane, London, E.C.4. (*Inventor: Howard John Fountain.*)

The invention concerns a combustion unit for adding heat to free-oxygen-containing exhaust gases from a diesel engine. As shown in the drawing, the combustion chamber *A* is mounted in an L-shaped part of an exhaust pipe *B*. This part comprises a

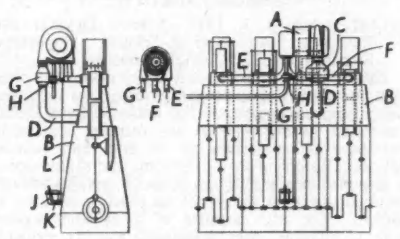


No. 711,773

short vertical duct *C* coupled by a flange to the engine exhaust pipe. The horizontal portion *B* is coupled to a manifold *D* leading to the water heater, not shown. The combustion chamber extends from an aperture *E* in the end wall, being mounted on a removable supporting plate *F* secured to the end casing. The chamber consists of a thin sheet metal cylinder *G* welded to the supporting plate, and lined with a refractory material cylinder *H*. The chamber extends into the second length of manifold *J* and is supported by a metal ring with three radial rods *K*. The refractory cylinder and the metal cylinder forming the combustion space are provided with five rows each of five ports *L*. To regulate the gas inlet port area there is an externally ported member *M*, having specially shaped ports *N*. A metal rod *O* serves to actuate the member *M* and to prevent its rotation. *P* is the gas or oil burner, which has an electric igniter *Q*. In operation the diesel engine exhaust gases, which are sufficiently rich in oxygen to support combustion, are admitted through the ports to the combustion space, and the burner is lighted. Once the refractory cylinder reaches incandescence, stability of flame and efficient combustion is assured and is substantially completed in the second length of duct *J*. Heat lost from the combustion chamber walls is transmitted to the exhaust gases which surround it, and a portion of the hot gases from the combustion space mixes with the remainder of the exhaust gases, so that the temperature of the gases flowing to the water heater is raised.—*July* 14, 1954.

711,904. January 24, 1951.—THE SUPPLY OF SCAVENGING AND COMBUSTION AIR TO INTERNAL COMBUSTION ENGINES, William Doxford and Sons, Ltd., William Hamilton Purdie, and Percy Jackson, all of Pallion Yard, Sunderland.

The invention relates to internal combustion engines provided with a fuel control member and having an exhaust driven turbo-blower for supplying to the engine air under pressure for combustion, supercharging and scavenging and also employing a source of power external to the engine for producing a supply of scavenging air and air for combustion during slow running at which the exhaust energy is insufficient to drive the turbo-blower to produce the air required, the object being to simplify the control of such an engine. As shown in the drawings, the engine is a multi-cylinder two-stroke opposed-piston



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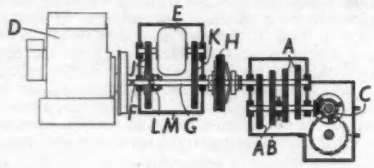
marine diesel engine. It has an exhaust driven turbo-blower of sufficient capacity to provide all the air required by the engine for combustion and scavenging during normal operation at load, and to deliver air under pressure to effect supercharging of the engine under full-load conditions. The external source of power employed is designed to drive the rotor and blower at a speed of about half the normal speed for full-load operation, the power required to drive the blower being about one-eighth of that needed for full-load operation. The turbo-blower *A* is mounted on one side of the body of the engine *B* and supplies air to the engine through the intercooler *C* and air pipe *D*. During normal load running the exhaust gases from the engine are supplied to the turbo-blower through the pipes *E* and *F*. For starting and slow running steam is supplied to the turbine through the steam pipe *G* and control valve *H*. The turbine nozzle ring is divided into three sections and two sections are supplied with exhaust gas from the engine through pipes *E* and *F*, while steam may be supplied through pipe *G* to the third section. The valve *H* controlling the supply of steam to the nozzle section is controlled from the engine control handle *J* via the lever *K* and rod *L* so that as the lever *J* is pushed over to increase the speed of the engine so the lever and rod shuts progressively the valve *H* and stops the supply of steam to the turbine as the load on the engine increases. Movement in the opposite direction opens the steam valve as the load on the engine is reduced. Modified designs are also shown in the specification.—*July* 14, 1954.

POWER TRANSMISSION

711,972. September 3, 1951.—VARIABLE SPEED POWER TRANSMISSION MECHANISMS, The Hunslet Engine Company, Ltd., Jack Lane, Leeds, 10, and John Frederick Alcock, of the company's address.

The invention relates to variable speed power transmission mechanisms for use with diesel or like locomotive or road vehicle engines, combining a variable speed toothed gearing and a hydraulic coupling or torque converter. As the drawing shows, there may be employed any conventional variable speed toothed gearing *A* contained in a housing *B* to transmit motion to the rail or road wheels through gear wheels *C*. Between the gearing *A* and the engine *D* there is provided a hydraulic transmission means *E* which may be in the form of a hydraulic coupling or a torque converter. Its axis is mounted parallel with a power input shaft, comprising two parts *F* and *G*,

the part *F* for connection to the engine and the part *G* connected to the gearing *A* through a friction clutch *H*. The two shaft parts *F* and *G* are respectively connected through gear wheels *J* and *K* to the input and output sides of the hydraulic means *E*. The adjacent ends of the shaft parts *F* and *G* are interconnectible by a clutch *L*. As shown, the hydraulic means and associated shafts and gear wheels are contained in a housing *M*. The arrangement is such



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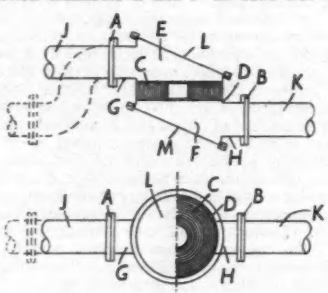
that with the two parts *F* and *G* of the input shaft connected together by the clutch *L*, the hydraulic means is rendered inoperative, both the input and output parts of the hydraulic means being then driven idly by the shaft parts *F* and *G*. In this condition power is transmitted through the gearbox *A* only. But when the clutch *L* is disengaged, the power is transmitted from the engine to the gearing *A* through the hydraulic means. At each step in a change of speed the toothed gearing can be connected to the engine either directly or through the hydraulic means. By the invention a wide range of control of the power transmitted from the engine is provided in a simple and convenient manner.—*July* 14, 1954.

MISCELLANEOUS

711,681. August 5, 1952.—Safety Devices for Pipelines, Ab Kemisk-Teknisk Apparatur, Strandvägen 5B, Stockholm, Sweden.

The invention consists of a safety device for pipelines for conveying explosive gases or gas mixtures, comprising an explosion trap enclosed by a casing connected to the pipeline and forming connection chambers at both sides of the trap and exhaust devices. Referring to the drawing, the safety device is mounted between flanges *A* and *B*, or alternatively between the other flanges of the pipeline sections, as shown. The trap consists of a helically wound strip *C* provided with interposed spacing elements to form narrow slits between the various turns. The helical strip is inserted in a casing *D* forming connection chambers *E* and *F* on each side of the



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trap. These chambers are in turn provided with pipe connections *G* and *H* to the pipeline sections *J* and *K*. The casing *D* is cut obliquely at both ends, and these ends are closed by rupture discs *L* and *M* consisting of thin aluminium sheet and mounted between flanges, thus forming the outer walls of the chambers *E* and *F*. The discs *L* and *M* are mounted at angles of about 25 deg. to the axes of the pipe connections *G* and *H*. The direction of flow through the slits in the trap *C* is perpendicular to the axes of the pipe connections *G* and *H*, and is thus also perpendicular to the direction of flow through these pipes. The volume of each of the chambers *E* and *F* between the trap and the adjacent pipe connection *G* or *H* is, in this case, smaller than that which is defined when the area of the slits measured perpendicularly to the direction of flow through them, is multiplied by the diameter of the adjacent pipe connection *G* or *H*. The whole arrangement is constructed symmetrical and functions equally well in either direction. An alternative design is also shown in the specification.—*July* 7, 1954.

Removal and Recovery of Sulphur from Fuels.—The Institute of Fuel, 18, Devonshire Street, Portland Place, London, W.1, is organising a conference on "The Removal and Recovery of Sulphur from Fuels," to be held at the Institution of Mechanical Engineers, 1, Birdcage Walk, S.W.1, on October 6 and 7, 1954. Details and application forms for preprints of papers may be had from the Secretary of the Institute of Fuel. All sessions of the conference will be open to the public, admission free.

Technical Reports

The Operation of a Barn Hay Drying Installation. (Ref. W/T28.) By P. Finn-Kelcey, A.M.I.E.E., A.M.I.B.A.E. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 15s., postage 4d.—This report gives an account of experiments similar to those described in Ref. W/T17. It is concerned with observations made on the operation, under practical conditions, on a West Midland farm, of a barn hay drying installation during the 1950 season. Details of individual hay drying operations, including labour requirements and running costs, are given. These are used to draw conclusions on operating costs for this type of plant in general use.

Aerodynamic Stability of Suspension Bridges. Part V. By G. S. Vincent. Bulletin No. 116. University of Washington Engineering Experiment Station, Seattle. University of Washington Press.—Five reports, of which this one is the last, have now been published by the University of Washington Experiment Station on the various aspects of the aerodynamic studies made since the Tacoma Narrows bridge failure. Investigations of a more general nature than in the previous reports are described in Part V, concerning methods of measuring damping on actual suspension bridges and for predicting fully all aspects of their aerodynamic behaviour from section model tests. Nevertheless, the preface of the report points out that too little evidence is yet available for any but the most carefully guarded statements regarding the broad application of findings made from a series of narrowly confined experiments. Apart from the studies arising from the Tacoma bridge, which in this case has been extended to section-model predictions, as noted above, the report also includes investigations of four other suspension bridges—the George Washington, Bronx Whitestone, Golden Gate and Paseo (Kansas City) bridges.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

AUTOMATIC CHANGE-OVER CONTACTORS FOR EMERGENCY LIGHTING SYSTEMS

No. 764 : 1954. Price 4s. The Institution has recently issued a revised edition of B.S. 764, "Automatic Change-Over Contactors for Emergency Lighting Systems," which takes into account the advances made since the previous edition was published in 1937. The contactors dealt with are those intended for use in circuits feeding safety lights and enable the lighting circuits to be automatically switched between the normal source of supply and an alternative source, when the normal source is interrupted, and reconnected when normal conditions are restored. In addition to specifying a range of standard current ratings, the performance and certain constructional details of double-pole change-over contactors for use on low voltages are covered. A 15A 30V size has been introduced and specific design requirements for this size are given. In the revision, it has been possible to specify the requirements of contact pressure and the temperature rise of operating coils with greater precision ; also to take into account the increased use of silver in contact manufacture and the development of certain forms of contact not previously covered. The use of the registered certification mark of the B.S.I., as evidence of compliance with the specification, is required.

The current cinematograph regulations require that automatic change-over contactors used in cinemas comply with B.S. 764, and it is understood that a revised edition of these regulations will be issued shortly. To enable new designs to be produced which will comply with the revised Standard, it will not be deemed to be fully applicable until six months after the issue of the revised cinematograph regulations.

AUTOMATIC CONTROLLING AND REGULATING SYSTEMS

No. 1523 : 1954. Section 3 (Price 4s.) and Section 5 (Price 5s.). The Institution has, for some years, been engaged in the preparation of a comprehensive glossary of terms used in automatic controlling and regulating systems of the closed-loop type, that is to say, monitored control systems. Section 2 of the glossary, covering the terms used in process control, was issued in 1949, and is at present being revised in the light of experience of its use. Section 1, "General Terms," and Section 4, "Automatic Regulators," have yet to be prepared. Section 3 "Kinetic Control," covers the terms used in kinetic control systems, i.e., systems for controlling the displacement, velocity or acceleration of a mechanical load, and includes terms covering basic principles, feedforward and feedback, types of control systems, parts of a servo system, types of servo-mechanisms, types of continuous control action, and the performance of control systems. In defining a monitored control system, notes are given setting out the difference between a closed loop system and a system with a closed sequence of dependence. An appendix is included giving the effects of derivative and integral controls in a displacement-displacement kinetic control system for a load possessing inertia and viscous friction. Section 5, "Components of Servo-Mechanisms," defines many of the terms which relate to the mechanical and electrical devices used in this field—particularly those dealt with in Section 3—and covers devices used for deviation measurement, amplifiers and their components, computing devices, stabilising and response-modifying devices, servo-motors and tachometers. Transductors, which are of increasing importance as components of magnetic amplifiers, have been fully dealt with ; their definitions have been made clearer by the inclusion of diagrams showing the various arrangements of windings. Important components of servo-mechanisms are synchros and their various modifications, which are known by a variety of existing proprietary and descriptive names. The difficulty of dealing with these has been solved by the inclusion of an appendix which compares the "Standard" terms with names of existing variations and gives some details of the latter in respect of the number of their winding paths and their energy transfer systems. Each section is comprehensively indexed. A distinction is drawn in the glossary between preferred and deprecated terms. The deprecated terms are included in the index so that the preferred term may be readily found.

Contracts

British Insulated Callender's Construction Company, Ltd., has obtained from the Norwegian State Railways an order for three Callender-Hamilton railway bridges of 190ft span. Hot dip galvanising of all steelwork is to be applied to them to reduce maintenance costs. The order includes the supply of additional sections to provide for any variation of span length that may be required. Fabrication and galvanising of the steelwork is being carried out by Tees-side Bridge and Engineering Works, Ltd., Middlesbrough.

Launches and Trial Trips

Ballarat, cargo liner ; built by Alexander Stephen and Sons, Ltd., for the Peninsular and Oriental Steam Navigation Company ; length between perpendiculars 490ft, breadth moulded 69ft, depth to shelter deck 43ft, draught deep load 29ft 9in, deadweight 12,790 tons, gross tonnage 9300 ; eight watertight bulkheads, six cargo holds, derrick complement of 5-ton and 10-ton derricks and also one to lift 80 tons, electric deck machinery ; one set of triple-expansion, double reduction geared turbines, service power 11,000 s.h.p., maximum power 13,000 s.h.p., astern power 7800 s.h.p., steam supplied at 500 lb per square inch and 800 deg. to 850 deg. Fah. by two Foster Wheeler boilers.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

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Fri. to Mon., Sept. 24th to 27th.—Church House, Westminster, London, S.W.1, 29th Annual Conference.

INCORPORATED PLANT ENGINEERS

Wed., Sept. 1st.—Leicester Branch : Bell Hotel, Leicester. "The Works Engineer and the Factories Act," H. M. District Inspector of Factories, 6.30 p.m.

Tues., Sept. 7th.—London Branch : Royal Society of Arts, John Adam Street, London, W.C.2, Open Forum, 7 p.m.

Thurs., Sept. 9th.—North East Branch : Roadway House, Oxford Street, Newcastle upon Tyne, "The Engineering Application of Electro-Deposited Metals," J. W. Oswald, 7 p.m.

Wed., Sept. 15th.—Kent Branch : Bull Hotel, Rochester, Kent. "The Causes and Prevention of Steam Plant Scale," W. F. Gerrard, 7 p.m.—Western Branch : Grand Hotel, Bristol, "Planning and Reconstruction of Bristol," R. W. Jefford, 7.15 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Aug. 17th.—Visit by a Party of Members to the Works of the Vacuum Oil Company, Ltd., Wandsworth, 2 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS

Tues., Sept. 14th.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Current American Practice in Heating, Ventilating and Air Conditioning," John K. M. Pryke, 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Wed. to Sun., Aug. 25th to 29th.—Ashorne Hill, Warwickshire Fifth Annual Summer School of Production Engineering.

IRON AND STEEL INSTITUTE

Mon. to Thurs., Sept. 13th to 16th.—Iron and Steel Engineers Group : 26th Meeting, Newcastle upon Tyne ; the meeting will be devoted to the presentation and discussion of seven papers on the developments at Consett Works, followed by visits to the works at Consett and Jarrow, and the Ore Discharge Terminal at Tyne Improvement Commissioners Quay.